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Robert Dudley Smith

Threads of Steel

Volume 60
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MECHANICAL ENGINEERING

August
1938

GEORGE A. STETSON, *Editor*

Dean Sackett's Formula

BECAUSE of his long service in the cause of engineering education and his more recent studies as chairman of the Committee on Student Selection and Guidance of the Engineers' Council for Professional Development, whatever Dean Robert L. Sackett has to say about the important subject to which his committee is directing its efforts should be attended with more than casual interest.

In a recent memorandum entitled "Chance and Choice in Engineering," Dean Sackett called attention to the fact that whereas the engineer makes it his business to eliminate chance from his work in so far as the application of science will permit, boys of preparatory-school age are taking a chance by choosing an engineering-college course without knowing all the facts necessary for sound judgment. Hence, he argues, schools, colleges, and the engineering profession should be concerned with reducing the chance of failure in this choice by a cooperative effort to help boys understand the foundations upon which a sound choice may be made.

He asks the question, What does engineering education ask of a prospective student? His answers to this question are as follows:

A definite liking for, and ability in, mathematics, particularly in solving problems.

A scientific curiosity and a deep desire to know *why* and *how* force, electricity, heat, and chemicals act and react as they do.

An interest in drawing, doing things, making things, seeing through them, understanding mechanical, electrical, and other devices, an ability to see in three dimensions or visualization. This latter valuable aptitude is called by various fancy names, such as "imagination," "creative imagination," seeing "spatial relations," "seeing things with eyes shut."

Character, courage, a genuine ambition, supported by dogged determination, and many other qualities are either necessary or helpful.

The boy who masters an engineering education has proved that he has capabilities for achievement not only in engineering but in other fields as well, as is attested by the careers of many successful men.

If an engineer is concerned that his profession should raise its standards, then he may give ripe counsel so that able boys with the desirable interests will feel encouraged to apply for admission to an engineering college. Those who are attracted by the spectacular and romantic should understand the nature of the severe discipline ahead of them and make their decision with their eyes open to the realities.

So much for the boy. What can the practicing engineer do about it? Dean Sackett's answer to this question has frequently been given in these pages: He can offer his services, individually or through the local section of his engineering society, to the persons in his community, the high-school principals and the boys themselves, who are most concerned with the practical phases of guidance. Dean Sackett's formula, faithfully followed, will build a better engineering profession for the future, and attack one more element of chance in men's lives.

Misapplied Science

LORD WEIR, honorary member of The American Society of Mechanical Engineers, in an address welcoming delegates to the International Engineering Congress at Glasgow, had some things to say about misapplied science that should concern not only the engineer but the layman. Quoting the well-known definition of engineering which lays stress on the use of the forces of nature for the benefit of mankind, the distinguished president of the congress reminded his hearers that too frequently, and particularly at the present moment, engineering skill and energy were being deflected from that purpose and were being applied to the destruction of our civilization.

Due to the manner in which the developments in technology affect the social life of our time, the engineer is becoming more and more involved in political and economic problems. While the engineer does not consider it to be his function to solve the problems his activities have placed before the world, and while few are rash enough to suggest that engineers would be more competent than others in working out the solutions, the engineer does employ a method of thought, as Lord Weir was at pains to point out, that might be used with advantage by those whose duty it is to lead the world through political and economic dangers.

This point of view has been frequently urged in this journal by a long list of engineers who have given thought to the problem of world peace and economic stability. The outlook at the present moment is discouraging. What industrial prosperity the world appears to enjoy depends largely for the moment on preparation for defense or for war. Great resources in human effort and material wealth are being diverted to these

ends, and while the ultimate result may be the salvation of civilization, if our leaders are successful to this end, the real desires of millions of persons for peace and security are held in suspense.

An international engineering congress, as Lord Weir showed, was a kind of triumph over an outworn nationalism, and although the world is suffering from a political and economic misapplication of science at the present time, he was a great believer in the engineer's method of attacking problems and in the virtues of analytical thinking. It may not be too much to hope that the age of reason, which should supplant the present age of nationalism and economic chaos, may find its surest footings in these nontechnical contributions that engineering is competent to make.

Publicity for Engineering

PUBLICITY for engineering, science, and technology is being increasingly urged and practiced. Hardly a meeting of engineers takes place without the mention of the desirability of publicizing the profession, its ideals, and its accomplishments. Industrialists similarly pattern their discussions and their practices. The corporation report, addressed to stockholders, employees, and the public, in terms offering a friendly understanding of mutual problems and interests, is becoming more frequent and popular.

Pamphleteering both by corporations and by trade associations has put in an appearance. Led by the late Edwin E. Slosson, the chemists made the nation conscious of their work and its significance so that science is now first-page news in the larger newspapers and Sunday supplements. Medicine has contributed its share to a rising popular thirst for draughts from the fountain of knowledge. The radio and the motion picture are approved vehicles for carrying developments in science and industry to the public. Thus is science spread by mechanisms of its own devising.

Between publicity and propaganda the difference is frequently vague. What is publicity to one man is likely to be offensive propaganda to another. The nonpartisan finds it hard to make an intelligent distinction, but he has his suspicions. There has even been organized a group in New York whose purpose is to teach how this distinction may be recognized, a sieve for facts and truth, as it were, which rejects "propaganda." The problem is a real one, as those who seek to embark upon a campaign of publicity must realize.

When it comes to publicity for industry and engineering, some delicate questions are involved. It cannot be assumed, as the politician is said to assume, that bad publicity is better than none at all. Politicians are individuals and their days are few. Industry and engineering are important factors in the social structure. Good publicity can aid them and the public they serve. Bad publicity, popularly known as "propaganda," can only aid by uncovering their weaknesses.

Because truth usually prevails eventually, those who are responsible for publicity on matters relating to industry and engineering should adopt an objective and realistic approach to their work. It is possible, as Robert Potter, of *Science Service*, pointed out at the Philadelphia forum of the American Engineering Council, to lead the public to expect the impossible, or the improbable. Pulling rabbits out of hats should be left for magicians. On the other hand, the glib traducers of engineering and industry should be exposed. Although time will deal with them, man's days are few, and hostility to technology, a vital motivating force in modern society, may retard development and result in unnecessary hardship to many persons.

So let's have frank and honest discussion of the place of industry and engineering, and truthful publicity on their objectives and value. Let us applaud the good efforts and condemn the bad. Let us place our case before the public with the facts on which sound judgments can be based, and rely upon good sense and intelligence to guide them.

Influence of Technology

MAKING a plea for a fresh point of view with respect to history, H. G. Wells, in an address before the League of Nations Union International Teachers' Conference on April 24, chose as his subject "The Poison Called History," and suggested that instead of glorifying nationalism, dynasties, and military exploits, attention be given to the influence of more civilizing factors, such for example, as metallurgy. For, as he said: "Up to the present day the irons, the steels, direct and rule and change life as no Alexanders. . . .have ever done."

This the engineer is prepared to admit; for he finds it his especial function to carry on the age-long developments of technology and hence he realizes more particularly than others, perhaps, the extraordinary powers man derives from even extremely subtle changes in the characteristics of materials. And when, to the single field of metallurgy are added the countless departments of applied science upon which engineering is based, and when some of the more obvious influences are even casually assessed, the effect is startling.

Yet even engineers are likely to give insufficient heed to the tasks of clarifying in their own minds what technology has accomplished and of persuading laymen to approach the study of history from the angle suggested by Mr. Wells. Fortunately, Mr. Wells is not the first to have urged attention to this phase of the interpretation of history. Increasing numbers of persons and groups are actively engaged in it. The series of lectures by Prof. D. C. Jackson, now appearing in MECHANICAL ENGINEERING, should do much for engineers in assisting them to a broad interpretation of the effects of engineering or human living. Interest in these lectures should extend beyond the little group of engineers to whom they may first appeal. They should be passed on to others, to laymen, and particularly to youths who are contemplating engineering as a career.

Contributions of METALLURGY *to* ENGINEERING PROGRESS[1]

By W. R. BARCLAY[2]

THE MOND NICKEL COMPANY, LTD., LONDON, ENGLAND

I MAGINE it is the ambition of most lecturers, invited as I am today to address a great Society such as yours, to contribute something new to our knowledge of engineering and its allied arts. I wish, however, at the outset of this address to disclaim any such ambition. I recall a remark of one of our greatest English physicists, Sir J. J. Thompson of Cambridge, to the effect that "the most important function of lectures to students is to arouse interest rather than to impart information, to make the hearers so interested that they will get the information for themselves." I believe that you will appreciate the compliment implied in applying this quotation to you, for I feel strongly that no true engineer, or indeed metallurgist, ever ceases to be a student, no matter what his age, or what eminence he may have attained in his profession.

It is with this thought in mind that I have chosen my subject today. I have for many years endeavored, within the limits of my opportunities, to bring together the engineer and the metallurgist, and to emphasize the community of interests which should exist between them. The Institute of Metals in Great Britain, whose Chair I have recently vacated, has always had this as one of its fundamental aims, and was indeed founded by engineers and metallurgists. Its first president was Sir William White, who was at that time our foremost British marine engineer, and since his day our presidents have included such men as Sir Henry Oram, Sir George Goodwin, each of whom held the position of Chief Engineer to the British Navy, and Sir George Beilby and Sir John Dewrance, who were essentially engineers rather than metallurgists. I cannot speak too enthusiastically of the influence that this close association of eminent engineers with my own profession has had in raising the status and extending the influence of that Institute. It is not only in connection with the Institute of Metals, however, but in my own general contact with industry, both in Europe and to some limited extent in your own country, that I have become more and more impressed with the need for the closest possible cooperation between our two professions, and particularly with the need for appreciation of the work that members of each are doing to help the other. I have, moreover, another reason for bringing this subject before you just now. I am convinced that from time to time it is vitally important to a true perspective of human progress in all its branches, and certainly a salutary corrective of undue optimism and pessimism to endeavor to carry the mind back over certain periods in the advance of technical knowledge, and form some kind of broad estimate of what has been accomplished in the application of science to industry in the fields with which we, as individuals or groups, may for the time being be concerned. We cannot without some appreciable mental effort realize what our forerunners have done for us. The young engineer or metallurgist entering industry today has, quite naturally, a tendency to take the present position for granted and to regard the attainments of the generation immediately preceding his as normal and perhaps even commonplace. If such a one could be suddenly transported, even if only for a week, to a quarter of a century ago, and be compelled to work with the materials then available and within the limitations of knowledge then attained, he would, on his return to present-day life, have a very much greater appreciation of what had been accomplished before he arrived on the scene, and, what is even more important, a far more acute sense of its inherent value to his profession.

We naturally tend to take things for granted, and today, the engineer who is faced, for example, with a corrosion problem, immediately thinks of such materials, readily placed at his disposal by the metallurgist, as the 8–18 per cent austenitic stainless steels or some of the nonferrous nickel-chromium or nickel-copper alloys, and he has almost automatically at hand a vast amount of data, worked out with close accuracy and minute detail, on the properties of these alloys. Such materials have entered into his everyday language. It is not easy for him to realize that had he had to face this problem, say in 1900 instead of in 1938, it would have taken on a vastly more difficult complexion.

The endeavor to make such reviews of the past and to enter into such a realization of the present has, I think, many advantages in the training and development of individual members of our respective professions, and not the least of these is the increased sense of responsibility which results from such a review. The accomplishments of the past are a legacy of inestimable worth, but that worth and value cannot be realized unless the fullest possible advantage be taken of them, to do which requires not only knowledge but a sympathetic appreciation of their aims, the labor expended, and the fundamental results which have been achieved.

It is obvious from this introductory statement of my case that I have undertaken an almost impossible task, for even if I limit my review to the period of my own industrial life (which I certainly intend to do), I should occupy far too much of your time and attention and even then succeed only in giving you what would amount to nothing more than a bare list of new or improved engineering metals and alloys.

I propose, therefore, to indulge in a general summary of the subject rather than in details, bearing in mind Sir J. J. Thompson's remarks already referred to, and endeavor by "arousing your interest, to send you in search of detailed information."

It will be necessary, in order to systematize my address, to place definite chronological limits on it, and you will, I hope, allow me to make this selection on a personal basis, dealing exclusively with developments within my own experience.

But first I would remark that in any review of progress in the science and art of metallurgy, and particularly in the development of new and improved products, account must be taken of the profound influence of fundamental scientific research. In

[1] The Fourth Calvin W. Rice Memorial Lecture delivered at the Semi-Annual Meeting, St. Louis, Mo., June 20–23, 1938, of The American Society of Mechnicaal Engineers. The first part only of this lecture is being published in this issue. It will be concluded in the September issue.

[2] Immediate Past-President, Institute of Metals, London, England.

the contribution of metallurgy to engineering, this factor has been particularly evident since the opening of the present century.

I am indebted to Prof. R. S. Hutton (1)[3] of the University of Cambridge for Table 1 of this lecture, illustrating what he terms. "Some milestones in the advance of physical metallurgy." This table, although not by any means complete, vividly illustrates the point I wish to bring out here.

TABLE 1 MILESTONES IN THE ADVANCE OF PHYSICAL METALLURGY

1864	Microscopic Study of Metals (H. C. Sorby)
1867	Electrical Conductivity and Constitution (A. Matthiessen)
1884	Eutectics (F. Guthrie)
1885	Modern Microscopic Study of Metals (F. Osmond and J. Werth)
1887	Thermoelectric Pyrometry (H. Le Chatelier)
1888–1891	Electric Resistance Pyrometry (H. L. Callendar, E. H. Griffiths, C. T. Heycock, and F. H. Neville)
1891–1921	Alloys Research, Institution of Mechanical Engineers
1893–1900	French Commission des Alliages
1892	Laboratory Electric Resistance Furnaces—Pt 1892, Ni 1899, NiCr 1908, W and Mo 1911
1899	Slip Bands (Ewing and Rosenhain)
1900	Phase Rule Application (H. Backhuis Roozeboom)
1901	Quenching of Alloys (C. T. Heycock and F. H. Neville)
1903	Göttingen Researches (G. Tammann)
1903	Beilby Layer (Sir George Beilby)
1911	Corrosion Research, Institute of Metals (G. D. Bengough)
1912	X-Ray Diffraction (Laue and W. H. and W. L. Bragg)
1918–1921	Single Crystals (J. Czochralski and H. C. H. Carpenter and C. F. Elam)
1919	Precipitation Hardening (Wilm. 1911)
1921	X-Ray Studies of Alloy Structure (A. Westgren)
1922	Creep at High Temperatures (J. H. S. Dickenson and National Physical Laboratory)
1923	Superlattices (Bain) (Borelius, Johansson and Linde, 1928)
1923	Anodic Oxidation of Aluminium (G. D. Bengough and J. M. Stuart)
1923	Corrosion and Passivity (U. R. Evans)
1924	Modern Development of Study of Electrodeposition (Research Department, Woolwich)
1926	Electronic Structure of Alloys (W. Hume-Rothery)
1927	Modern Quantitative-Spectroscopic Analysis
1928	Electron Diffraction (G. P. Thomson)
1933	Electron Microscope (E. Brüche)
1934	Superlattices: Theoretical Explanations (W. L. Bragg and E. J. Williams)
1934	Theory of Alloy Phases (H. Jones)

Time will not permit me to attempt to show you how directly some of these "milestones" have influenced practical developments in industrial metallurgy, but I would especially draw your attention to the vital importance of such discoveries as those relating to the microscopic study of metals, thermoelectric pyrometry, precipitation hardening, high-temperature and creep properties, as well as many others affecting not only the development of new alloys but the improvement of existing ones, and the adaptation of these materials to the special requirements of modern engineering. Indeed, it is not too much to say that every advance noted in the following review furnishes a more or less striking example of the intimate relationship of fundamental research to modern industry.

ALLOY STEELS

As I look back, I realize that the greatest metallurgical advance impressed on my mind as a young student was the introduction of alloy steels, and although my own work has been almost entirely in the field of nonferrous metals, I hope you will allow me in the first place to spend just a short time in outlining some of the really spectacular accomplishments of metallurgy in the ferrous field.

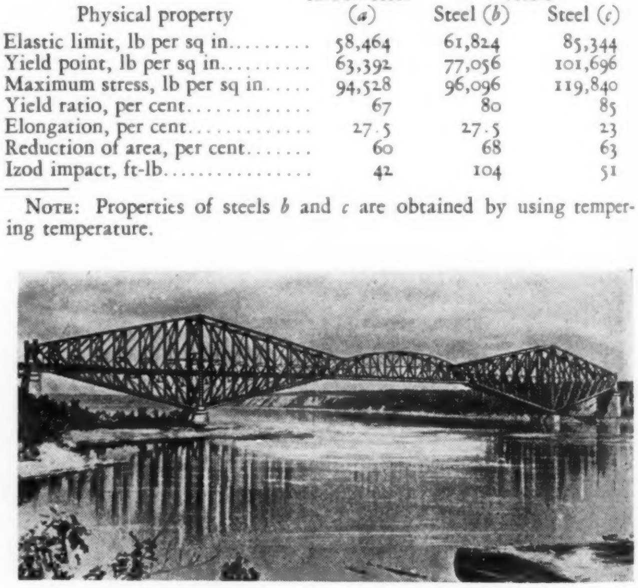
I began the study of metallurgy in 1893, only a very few years after the epoch-making work of Riley (2) on nickel steels was published, and I have a vivid recollection of the revolutionary effect of this work, not only in regard to its industrial applications, but also as affecting the mental outlook of the metallurgists of that day. It is of interest to point out that although alloy steels since that day have undergone noteworthy developments, the nickel steels still remain the most widely used of all groups, and attract immediate attention for their very valuable engineering properties.

The addition of nickel to plain carbon steels not only improves the mechanical strength of the steel but greatly facilitates heat-treatment, and the production of uniform and reliable properties. The compositions in general use vary from a nickel content of 1 or 1.5 per cent to 6 per cent, and within these ranges of composition maximum stress values up to 150,000 lb per sq in. or even higher can be obtained. Table 2 illustrates the effect of a 3 per cent nickel addition in a 0.3 per cent carbon steel, in the quenched and tempered condition.

TABLE 2 COMPARISON OF THE PHYSICAL PROPERTIES OF 0.3 PER CENT PLAIN CARBON STEEL WITH TWO 3 PER CENT NICKEL STEELS

Physical property	0.3 per cent carbon steel (a)	3 per cent nickel steels Steel (b)	Steel (c)
Elastic limit, lb per sq in.	58,464	61,824	85,344
Yield point, lb per sq in.	63,392	77,056	101,696
Maximum stress, lb per sq in.	94,528	96,096	119,840
Yield ratio, per cent	67	80	85
Elongation, per cent	27.5	27.5	23
Reduction of area, per cent	60	68	63
Izod impact, ft-lb	42	104	51

NOTE: Properties of steels *b* and *c* are obtained by using tempering temperature.



THE QUEBEC BRIDGE

(In the construction of this bridge which spans the St. Lawrence River about 16,000 tons of nickel steel were used. The cantilever piers are 1800 ft apart.)

It will be readily understood how greatly the engineer has been helped by such improvements in the properties of his ordinary materials; illustrations of their value are to be found in every branch of engineering, from the building of bridges to the construction of aeroplane engines.

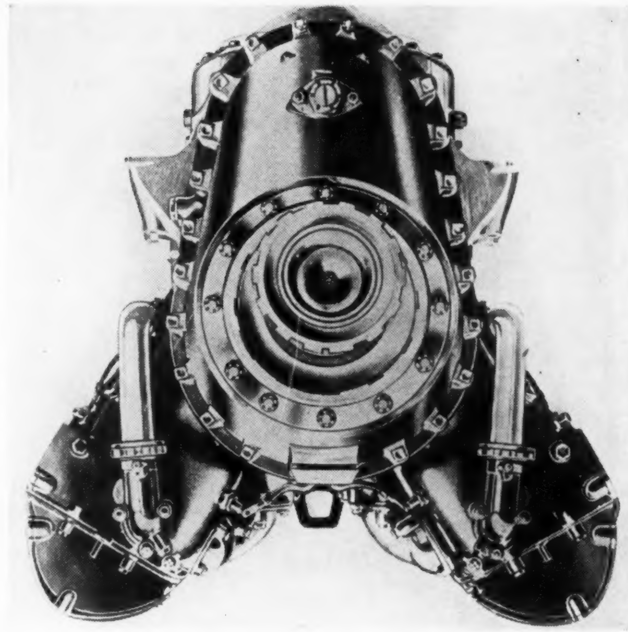
An interesting minor application of nickel steels is mentioned by Sir Henry Fowler (3), who states that by the adoption, for hand chisels, of a straight nickel steel of the approximate composition of 0.4 per cent carbon, 3.5 per cent nickel, and 0.5 per cent manganese, heat-treated at from 900 to 950 C and oil-quenched, a saving in wear corresponding to the proportion 18 to 1.2 has been effected on an English railway. It is of interest

[3] Numbers in parentheses refer to the Bibliography at the end of the lecture.

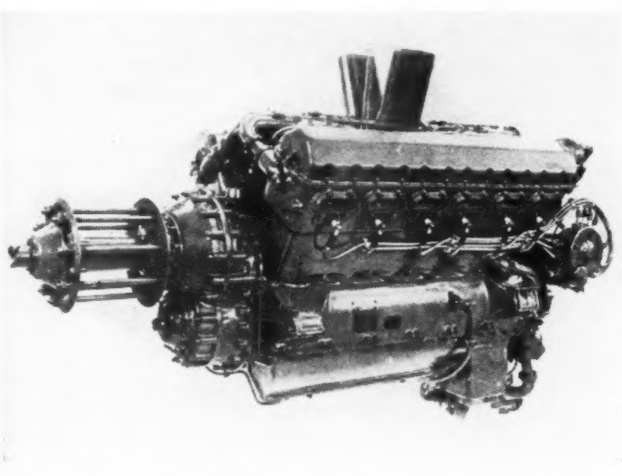
to add here that the London Midland and Scottish Railway, in England has recently presented to the Science Museum in London a chisel of the foregoing composition, driven cold through a $2^1/_4$-in. block of mild steel without damage to the cutting edge.

May I call your attention also to the quite extraordinary value of the nickel steels under conditions of use at abnormally low temperatures. Below room temperatures the ordinary carbon steels tend to become brittle. The addition of nickel exercises a profound influence in inhibiting this tendency and a 3 per cent nickel steel will retain its roughness down to temperatures of say 100 C or lower. This property is even more strongly manifested with increasing nickel content.

Although for purposes of comparison, and to comply with convention, I have illustrated the numerical values of the mechanical properties of materials for the most part by the 'maximum stress' figures, I desire to emphasize, as a number of my metallurgical colleagues (4) have already done, that such figures are of little or no value to the engineer unless all the other mechanical properties of the material are also considered, since the maximum stress indicates simply at what load the part will break, and the engineer does not design structures on such a basis as that. What he requires is a material which will bear all the strains he considers it will be likely to be called upon to withstand, without distortion, and this latter factor is indicated more accurately by what we now term "proof stress" than by maximum stress, particularly when proof-stress values are read in conjunction with results of other recognized tests such as Rockwell, Brinell, and Izod impact.



SCHNEIDER AEROPLANE ENGINE IN WHICH NICKEL STEELS HAVE ALSO BEEN USED EXTENSIVELY



UNIFORM AND RELIABLE PHYSICAL PROPERTIES OF NICKEL STEEL AS LIGHT ALUMINUM ALLOYS HAVE BEEN USED TO ADVANTAGE IN AERONAUTICAL ENGINEERING AS, FOR EXAMPLE, IN THIS ROLLS ROYCE KESTREL ENGINE

TABLE 3 PROPERTIES OF TYPICAL COMMERCIAL STEEL

Composition	0.5 C, and 0.8 Mn
Condition	Hardened and tempered
Yield point, lb per sq in	67,200
Maximum stress, lb per sq in	112,000

TABLE 4 PHYSICAL PROPERTIES IN TENSION AND FATIGUE OF A Ni-Mn-Cr STEEL[a] AFTER HARDENING IN AIR FROM 800 C AND TEMPERING AT VARIOUS TEMPERATURES

Tempering temperature, C	.....	200	400	500	600
Elastic limit, lb per sq in	44,800	81,088	119,392	115,808	91,616
Yield point, lb per sq in	176,512	173,600	180,320	159,712	141,792
Maximum stress, lb per sq in	244,384	226,688	219,296	184,576	157,024
Elongation, per cent	10.8	12.5	10.0	15.0	17.5
Reduction of area, per cent	36.6	41.6	36.2	46.4	55.1
Fatigue range, lb per sq in. Wöhler	±101,920	±115,360	±106,400	±92,960	±79,520

[a] Chemical composition, per cent: 0.3 carbon, 0.22 silicon, 0.56 manganese, 4.3 nickel, and 1.44 chromium.

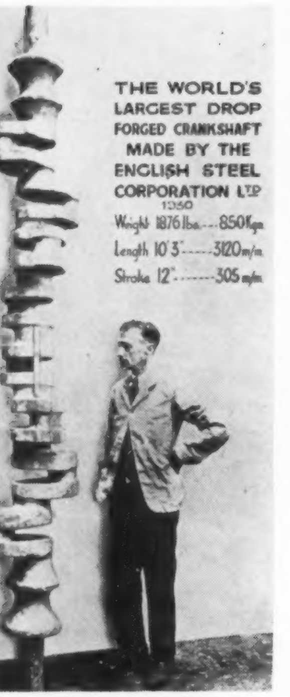
TABLE 5 PHYSICAL PROPERTIES OF CARBON, NICKEL, NICKEL-CHROMIUM, AND NICKEL-CHROMIUM-MOLYBDENUM STEELS

Type of steel	C[a]	Ni[b]	Ni-Cr[c]	Ni-Cr-Mo[d]
Chemical composition:				
Carbon	0.35	0.34	0.31	0.36
Nickel	0.15	3.65	3.62	2.70
Chromium	0.03	0.07	0.82	0.58
Molybdenum	..	...	..	0.57
Physical properties:				
Elastic limit, lb per sq in	.....	44,800	67,200	98,560
Yield point, lb per sq in	62,272	69,440	95,648	105,056
Maximum stress, lb per sq in.	103,712	109,312	117,824	121,184
Elongation, per cent	16	21	25	23
Reduction of area, per cent	28	43	66	64
Brinell hardness number	221	229	247	254
Izod impact, ft-lb	24	38	74	61

[a] Quenched at 850 C in oil, tempered at 620 C for 2 hr, and cooled in air.
[b] Quenched at 900 C in oil, tempered at 650 C for 2 hr, and cooled in water.
[c] Quenched at 300 C in oil, tempered at 650 C for 2 hr, and cooled in water.
[d] Quenched at 900 C in oil, tempered at 670 C for 3 hr, and cooled in water.

In order to afford you a brief view of the advances made in alloy steels in general, I give in the first place, in Tables 3, 4, and 5, a comparison between an ordinary commercial steel of typical composition made by the Siemens-Martin or open-hearth process, and a few modern high-grade alloy steels.

It is necessary to interpose here that this great development of alloy steels has been brought about not only by the natural prog-



ress of research and by the demand of the engineer for materials of greater strength, but as a result of the fundamental practical difficulties met with in the heat-treatment of ordinary carbon steels in obtaining a really satisfactory combination of strength with toughness and ductility. In the hardening of large masses of materials, it is nearly impossible, in ordinary carbon steels, to obtain thoroughly reliable and uniform properties throughout the mass, whereas with an alloy steel of suitable composition even the largest masses can be almost uniformly hardened from surface to center.

HIGH-SPEED STEELS

Although the earliest beginnings of what are now termed "high-speed steels" may be plainly traced back as far as Mushet in 1857, yet in a very real sense they belong to the advances of the past century and for much of their astounding development credit must be given to two of your own countrymen, Taylor and White (5), from the year 1900 onward.

The basic composition of all such steels depends on the introduction of chromium and tungsten. In this connection, however, the employment of the elements vanadium and molybdenum must not be overlooked, and even the most superficial review of the literature of metallurgical research arouses feelings of profound admiration for the almost infinite patience, experimental skill and resource displayed in bringing these materials of engineering service to their present standard. They are now so well known by engineers that it is hardly necessary to give details of their composition and properties, and I cite the example given in Table 6 simply by way of illustration (6).

TABLE 6 COMPOSITION AND PROPERTIES OF TUNGSTEN-CHROMIUM HIGH-SPEED STEEL

Chemical composition:	
Tungsten, per cent	18.68
Chromium, per cent	2.80
Carbon, per cent	0.66
Physical properties:[a]	
Tensile strength, lb per sq in.	126,600
Yield point, lb per sq in.	108,100
Elongation, per cent	17
Reduction of area, per cent	30
Brinell hardness	270

[a] Annealed condition.

Before leaving the subject of alloy steels, I must refer briefly to the relatively modern development of the use of copper as an alloying element in steels. A number of alloy steels, some of which have been developed in your own country to a very high standard of quality, contain copper up to 1 per cent, usually in conjunction with nickel or manganese and chromium. Such steels have been found to possess valuable properties, particularly in regard to yield point and ductility. There is also some evidence that these alloys show improved resistance to certain types of corrosion (7).

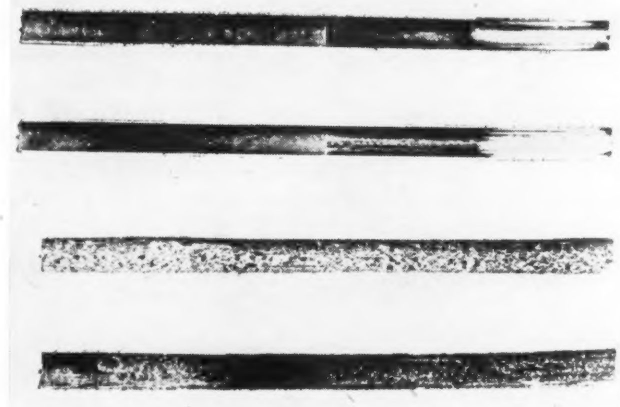
It is difficult to assess the exact value to engineering progress of the enormous development of alloy steels briefly reviewed in the foregoing paragraphs, but it is obvious that the commercial production of steels possessing a maximum tensile strength of the order of 200,000 to 250,000 lb per sq in. has, by increasing the strength-weight ratio, enabled designers to effect material reductions in the weight of engineering structures. This is particularly evident in automobile engineering, in the development of the modern locomotive, and, more strikingly still, in aeronautical work. Such materials have also enabled the engineer to operate boilers and steam machinery in general at considerably higher pressures and higher temperatures than were even dreamed of 40 years ago.

A further factor of no less importance than the saving of weight in modern engineering construction is the longer life now made possible. In this direction, the value of the work of research metallurgists in increasing our knowledge of such important factors as (*a*) mechanical and corrosion fatigue, (*b*) creep under stress at both normal and high temperatures, (*c*) factors which influence brittleness in steels and machining properties (8), and (*d*) above all the intensive study of reactions of corrosive agents, whether atmospheric or other, have all rendered incalculable service to modern engineering.

CORROSION- AND HEAT-RESISTING STEELS

Table 7, for which I am indebted to Prof. F. C. Thompson of Manchester University, embodies an admirable summary of the principal alloy steels of this class. In a recent address (9) to the Manchester Association of Engineers, Thompson calls particular attention to the properties of sheets containing from 20 to 25 per cent chromium with 18 per cent nickel, which combine high resistance to scaling with considerable ductility. In this address, attention is also drawn to the value to engineers of the high strength and resistance to creep shown by this class of alloy in temperature ranges of the order of 800 to 1000 C. An example is cited of an alloy having a composition of 20 per cent chromium, 7 per cent nickel, 4 per cent tungsten, 1.5 per cent silicon, and 0.3 per cent carbon, which has a creep limit of over 2000 lb per sq in. even at temperatures slightly above 800 C.

On the general subject of corrosion and heat-resisting steels I should like to quote briefly J. H. G. Monypenny, whose book on the subject (10) has become a classic in the English language. His conclusions are summarized in the following terms: "As a result of his investigations on these austenitic steels, investigations carried out over a period of years and to a large extent



A COMPARISON OF CORROSION IN BRASS (TOP TWO) AND 70 CU-30 NI (BOTTOM TWO) CONDENSER TUBES

TABLE 7 TYPICAL COMPOSITION AND PROPERTIES OF SOME HEAT-RESISTING STEELS[a]

Reference number	1	2	3	4	5	6	7	8
Approximate analysis:								
Carbon, per cent	0.40	0.30	0.25	0.45	0.43	0.25	0.50	0.50
Chromium, per cent	13.50	20.00	20.00	14.00	10.00	25.00	30.00	12.00
Nickel, per cent	13.50	7.00	7.00	28.00	37.00	18.00	...	60.00
Tungsten, per cent	2.50	4.00	...	4.00	...	...	...	...
Silicon, per cent	1.50	1.50	1.50	1.50	0.25	2.00	1.50	1.50
Physical properties at room temperature:								
Yield point, lb per sq in	82,800	85,120	67,200	71,680	62,720	73,920	56,000	56,000
Max stress, lb per sq in	134,400	136,640	125,440	112,000	85,120	112,000	100,800	114,240
Elongation, per cent	37	34	42	30	40	29	18	33
Reduction of area, per cent	42	41	46	45	50	46	30	47
Brinell hardness	260	260	190	200	200	195	215	185
Izod impact, ft-lb	50	35	50	35	50	50	5	50
Physical properties at 800 C:								
Max stress, lb per sq in	53,760	56,000	51,520	47,040	38,080	44,800	Note *A*	51,520
Elongation, per cent	32	36	38	32	44	33	Note *A*	43
Reduction of area, per cent	60	60	61	43	61	48	Note *A*	53
Creep stress, 10^{-6} lb per sq in. per hr at 1000 hr	1.00	1.20	0.50	0.55	...	0.50	0.28	0.48
Coefficient of expansion, 10^{-6} deg C at 20 C	15.10	13.30	15.70	14.10	7.30	14.30	8.70	11.00

[a] Specimens of forged material.
NOTE *A*: Values are of the same order as for carbon steel.

TABLE 8 PHYSICAL PROPERTIES OF HARD STAINLESS STEEL[a]

Tempering temp, C[b]	Yield point, lb per sq in.	Maximum stress, lb per sq in.	Elongation, per cent	Reduction of area, per cent	Brinell hardness	Izod impact, ft-lb		
...	.....	228,480	3.0	3.2	444	5	3	3
300	.....	224,000	5.5	6.7	444	5	5	5
500	.....	233,856	9.0	24.6	444	8	4	..
550	.....	204,288	9.0	30.6	437	11	11	7
600	129,472	145,600	11.5	27.6	302	7	10	7
650	112,448	126,336	17.5	37.8	269	15	10	15
700	104,832	120,960	21.0	52.2	241	26	26	21
750	94,976	116,032	21.0	44.6	241	28	33	34

[a] Chemical composition, per cent: 0.37 carbon, 0.19 silicon, 0.15 manganese, and 11.7 chromium. Bars treated were of $1^1/_8$ in. diam.
[b] All samples were air-hardened at 900 C, tempered at temperatures indicated in this column, and then water-quenched; therefore, material in first line was air-hardened only.

TABLE 9 RANGE OF PHYSICAL PROPERTIES OF CORROSION-RESISTING STEELS AT 15 C

Type of steel	0.5 per cent proof stress, lb per sq in.	Maximum stress, lb per sq in.	Elongation, per cent	Reduction of area, per cent	Brinell hardness	Young's modulus, lb per sq in.
18Cr-2Ni:						
Wrought[a]	78,400–112,000	100,800–134,400	25–15	60–45	240–280	30,240,000
Castings[a]	44,800– 67,200	89,600–112,000	18–15	40–30	200–240	30,240,000
18Cr-8Ni:						
Wrought[b]	33,600– 40,320	82,880–100,800	60–40	60–40	160–180	28,896,000
Castings[b]	31,360– 40,320	67,200– 89,600	50–25	50–25	160–200	28,896,000
12Cr-12Ni:						
Wrought[b]	31,360– 38,080	78,400– 89,600	60–40	60–40	130–150	28,896,000

[a] Hardened and tempered.
[b] Fully softened.

independently of the work of Strauss and Maurer, the author considers that an alloy containing 15–16 per cent chromium and 10–11 per cent nickel possesses the best all-round combination of properties desirable in such a steel for most of the purposes for which it might be used."

Before leaving this section of my subject, and as another illustration of the patient, systematic, and skilled investigatory work which lies behind all the metallurgical advances referred to in this lecture, may I also briefly recount the story of the discovery of stainless steel, as recorded by Brearley in collected communications to the press? (11) The story dates back to the year 1912, when Brearley had to deal with the problem of the resistance of gun steels to fouling and erosion. In a report on the subject, he sets out the main properties required of such steels as follows: (*a*) High melting point; (*b*) great resistance to wear at high temperatures; and (*c*) immunity from hardening on sudden cooling. He concluded that these properties were not to be found in a superlative degree in any of the ordinary commercial steels at that time on the market, and concluded that "the most suitable material would appear to be an alloy of iron and chromium."

In October of the same year, he carried out a series of experiments on these alloys, and although a number of results were disappointing (partly owing to inadequate melting equipment), he found that an alloy containing 0.24 carbon and 12.8 chromium met the previously mentioned requirements in an appreciably higher degree than any other then existing materials.

It will be noted that this investigation did not aim directly at the production of a stain- or corrosion-resisting steel. It was only later, in microscopic investigations of its structure (involving the processes of etching), that Brearley first observed its extraordinary resistance to corrosion attack, and suggested, *inter alia*, its potential value as a corrosion-resisting material.

You will see that, like many other such discoveries, it was superficially an accident, but behind it lay many years of experienced research work, together with the ability to make minute and careful observations, which is to a large extent the secret of all scientific discovery. The chemical composition and physical properties of one hard stainless steel is given in Table 8.

Later, of course, the original iron-chromium alloy of Brearley was appreciably improved by the addition of nickel, and many other research

TABLE 10 COMPOSITION AND PHYSICAL PROPERTIES OF HIGH-NICKEL HIGH-CHROMIUM (STAINLESS) STEELS

Steel	*A*	*B*	*C*	*D*
Chemical composition:				
Carbon, per cent	0.10	0.10	0.21	0.24
Silicon, per cent	0.25	1.34	0.36	0.26
Manganese, per cent	0.24	0.22	0.18	0.29
Chromium, per cent	15.20	15.00	15.40	20.20
Nickel, per cent	11.40	9.00	10.30	8.40
Physical properties:				
Yield point, lb per sq in	42,784	36,736	42,112	60,480
Ultimate strength, lb per sq in	87,136	131,936	102,368	118,729
Elongation, per cent	70	57	64	50
Reduction of area, per cent	72.6	51	67.8	51.4
Brinell hardness	137	163	163	185
Izod impact, ft-lb	105–109	115–120	112–120	118–120

workers both in Europe and America have contributed to the development of the modern stainless steels. The properties of some of these steels are given in Tables 9 and 10.

To outline, even in the briefest form, the applications of stainless steels to engineering progress would itself occupy far more than the time of one lecture, and I am sure that you are at least as familiar as I am with many of the services these metallurgical products render to your profession. I must, however, call your attention to their use in chemical plants. The modern chemical plant would be quite impossible were it not for stainless steel, particularly for such strenuous service as the nitric-acid plant, and the manufacture of dyestuffs and other complex chemical products possessing severe corrosive properties.

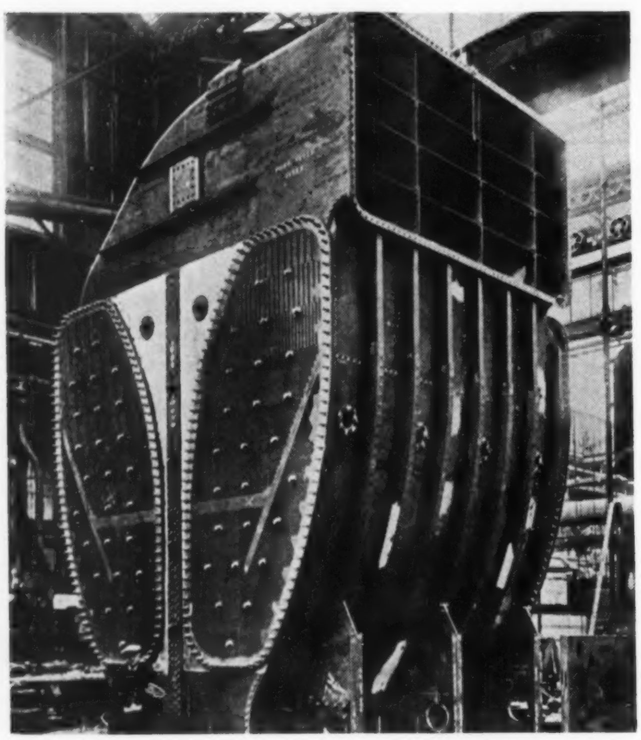
In this connection I wish to emphasize especially the value of such addition elements as molybdenum[4] in enhancing corrosion resistance (12). Data in Table 11 emphasize this fact.

TABLE 11 DATA ON THE CORROSION RESISTANCE OF CR, CR-NI, AND CR-NI-MO STEELS

Reagent	Temp, C	14Cr steel	18Cr-8Ni steel	18Cr-8Ni-2.5Mo steel
5% acetic acid..........	BP	Attacked	Unaffected	Unaffected
B.P. acetic acid.........	BP	Severely attacked	Attacked	Practically unaffected
Glacial acetic acid......	BP	Severely attacked	Attacked	Slight attack
10% formic acid........	60	Attacked	Unaffected	Unaffected
80% formic acid........	60	Severely attacked	Attacked	Unaffected
1% lactic acid..........	BP	Severely attacked	Attacked	Unaffected
10% oxalic acid........	70	Severely attacked	Some attack	Unaffected
0.5% sulphuric acid....	20	Severely attacked	Slight attack	Unaffected
5.0% sulphuric acid....	20	Severely attacked	Attacked	Practically unaffected
1.0% sulphuric acid....	40	Severely attacked	Attacked	Practically unaffected

I must also mention at least one other direction in which this class of modern corrosion- and heat-resisting steel is proving a valuable factor in engineering progress; that is, in the improvement of the steam turbine. You will be aware that in this field of engineering results have been achieved recently which would have been quite impossible in the earlier days of Sir Charles Parson's revolutionary invention. As one example of many, Sir Robert Hadfield, in a privately circulated paper (13), stated: "One of the steels manufactured by his company and used in an experimental turbine has successfully achieved 26,000 hours of running service, of which 22,000 have been at temperatures in the region of 1000 F, in which a distinct red color is visible."

[4] Space does not permit more than a passing reference to the prevention of weld decay in 18/8 stainless steels by the addition of columbian or titanium.



ONE OF THE MAIN CONDENSERS ON THE "QUEEN MARY," WHICH ARE EQUIPPED WITH 70 CU-30 NI TUBES

Stainless steels are also entering more and more into aircraft construction, and the tendency to larger and heavier flying units will undoubtedly still further increase their applications.

As another illustration of the service of metallurgy in this field to engineering, may I very briefly refer to the value of these alloys, particularly those containing high percentages of nickel and chromium, in (*a*) the economic generation of heat, (*b*) the construction of superheaters and heat-exchange devices, (*c*) carrier bars and conveyors in continuous heat-treatment furnaces, (*d*) oil-cracking plants, and (*e*) particularly exhaust valves in internal-combustion engines? A valuable review of the properties and uses of heat-resisting steels has recently been made by Hatfield (14).

Another outstanding development of recent years, and a further example of the value of alloying additions to ferrous metals, is found in the improvements effected in cast iron by the addition of nickel, either alone or in combination with other alloying elements. This subject has been so fully and admirably dealt with by Dr. P. D. Merica in his Howe Memorial Lecture (15) to the A.I.M.E. last year that I will content myself with this brief mention and refer you to that lecture for details, not only of the metallurgical subjects of these developments but of their engineering applications.

(*To be concluded in the September issue*)

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Mechanical Problems in

DIESEL-TRACTOR DESIGN

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BY WAY OF introduction to this subject, reference is directed to the paper, "The Diesel Tractor and Excavator," presented at the Third National Oil and Gas Power Meeting of the A.S.M.E. in June, 1930 (1).[1] At that time, a résumé of an extended Diesel experimental program was discussed, and the basis of future trends was forecast. By the end of the following year, results materialized to the point of manufacture and sale of a new line of Diesel tractors. About two and one-half million horsepower of Diesel engines have been built since then, following the concepts advanced and the principles initiated in that paper plus the accruing amplifying influences of continuous research. High lights of experience gained through the progress of the intervening years serve as the basis for the subject matter of this paper.

The very nature of tractor service dictates exacting demands. Fundamentally, the track-type tractor must be capable of continuous operation at full load for indefinite periods of time in all sorts of weather and environment and in the hands of labor capable of inflicting an unusual amount of abuse. For such reasons, the basic tractor problems are similar to both gasoline- and Diesel-motored track-type tractors. Extended service records fail to reveal any broad differences in design problems of clutches, transmissions, final drives, chassis, or tracks for either type of motor when the unit is destined for heavy-duty purposes. For the sake of interest in factors that differ, in problems that are distinctly modern, this paper will deal primarily with the Diesel engine as applied to track-type tractor use. For brevity, these problems influence design factors of Diesel-engine construction in three general divisions as classified according to field service:

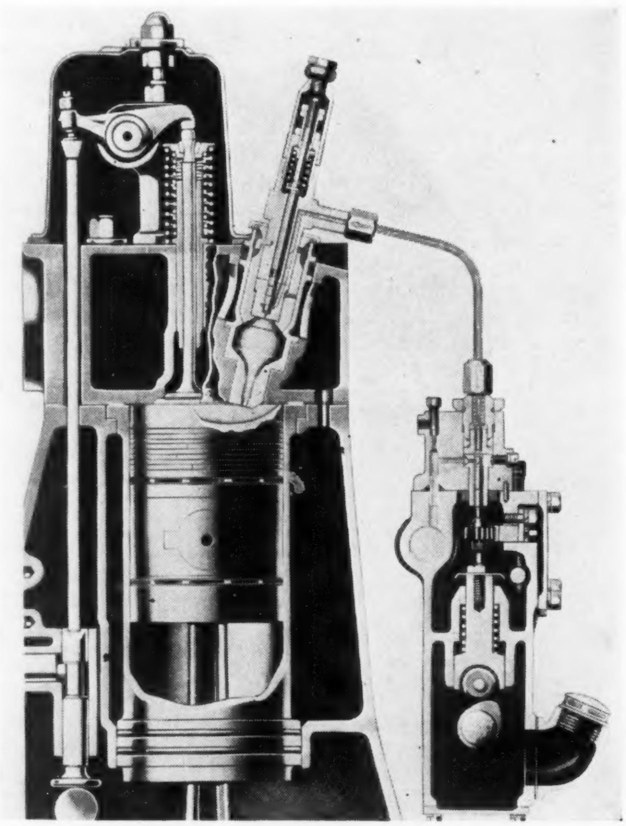

FIG. 1 PRECOMBUSTION-CHAMBER DIESEL ENGINE SHOWING FUEL-INJECTION SYSTEM AND COMBUSTION CHAMBERS

(1) Those factors which predetermine a season's continuous operation without major repair or shutdown, such as the fuel system, combustion process, lubrication system, and freedom from migrant distortions of heat-saturated parts.

(2) Those factors which permit ease of maintenance by the average tractor operator, such as provision for the burning of clean fuels, freedom from delicate adjustments, and accessibility in the cleaning of filters, sumps, air cleaners, and breathers.

(3) Those factors which provide economical repair and ready replacement of wearing parts in the field, such as liners, valves, and unit assemblies.

The proper balance of these factors in correct relationship yields economical field operation. The primary reason for the existence of the Diesel engine is its native ability to afford high economy in the consumption of relatively cheap fuels. Low fuel costs plus economical maintenance must total less money than competitive units to justify the Diesel tractor's economic survival. The whole history of Diesel research and service is, therefore, intimately interwoven in the fabric of operating economics.

Normally, a Diesel track-type tractor's season of operation is about 3500 hr per year. The fuel system and combustion process should have inherent qualities that maintain uniformity of power output for this period without major repairs or the necessity for adjustments requiring expert training or delicate instruments. Diesel fuels contain, essentially, hydrogen and carbon, and the combustion process releases these elements to activities that require exacting and systematic control. The series of chemical equations involving combustion must react in proper sequence or the economical picture is badly distorted. To provide these combustion-functioning controls for a season's continuous operation, without adjustment, taxes the initial design of the fuel system and the combustion process to the utmost. Tractor service does not permit frequent adjusting and

[1] Numbers in parentheses refer to the Bibliography.

Contributed by the Oil and Gas Power Division and presented at the Spring Meeting, Los Angeles, Calif., Mar. 23–25, 1938, of The American Society of Mechanical Engineers.

checking by experts as does other service with large Diesel units. Furthermore, the power output must be uniform with respect to time, and the torque characteristics must be equivalent in comparable models.

To consider for a moment a contractor's operation involving some ten or twenty units of a similar model engaged in levee construction, all of these units must pass over the same terrain, be subject to the same load, and still keep pace with each other with respect to time. One lagging unit delays the work schedule of the entire group. Technically speaking, every tractor must describe identical torque and horsepower curves. To provide the consequently necessary uniformity of product without requiring adjustments involving the injection and combustion system places demands on the accurate knowledge and definite manufacturing control of the dimensions and contours of performance-controlling elements. Furthermore, normal field operation must not seriously alter or deviate these functional controlling elements. Long periods of uniform combustion control are obtained only if the elements involved maintain themselves with repeatable regularity and carbon accumulations and depositions are avoided and held to the minimum on all parts affecting functional controls. The sum total of these qualifications is a combined fuel-system and combustion-chamber design in which design features and manufacturing limits are capable of predicting engine performance.

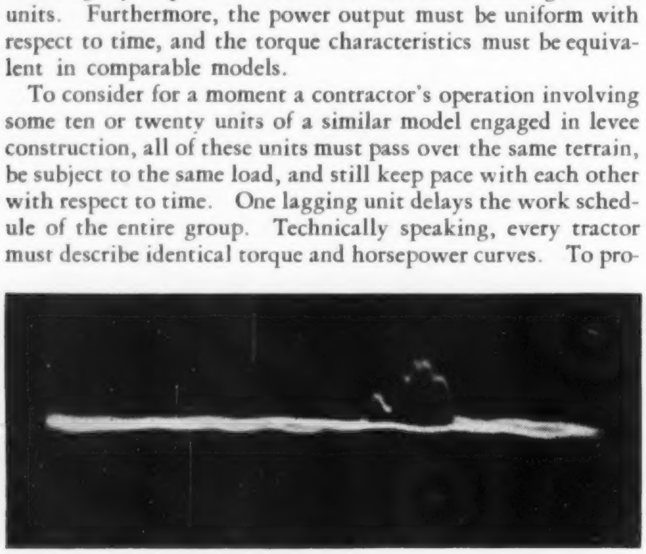

FIG. 2 OSCILLOGRAPH OF FUEL-INJECTION VALVE-LIFT CURVE

How is this to be achieved? The precombustion-chamber Diesel engine is chosen for illustrative purposes because it represents an oil-burning unit in which design and manufacturing detail can be controlled within practical limits so as to predetermine field performance. When properly designed and built, it represents, at present, the most ideal Diesel system for application to heavy-duty track-type tractor service. To justify this statement, reference to fundamental principles may not be amiss at this juncture. The initial consideration in the Diesel process is the fuel-injection mechanism, preferably of a simple foolproof structure, that will supply fuel at predetermined rates in regulated quantities at the pressures desired for proper atomization. In Fig. 1, a typical precombustion-chamber Diesel engine is illustrated, showing the fuel-injection system as consisting essentially of a fuel pump, fuel line, and fuel-injection valve attached to the precombustion-chamber engine. By experience, it has been found satisfactory to judge an injection system's performance by its fuel-injection valve-lift curve. Correlation between a fuel-injection valve-lift curve in open air with that in a nitrogen chamber, as compared with the actual curve obtained on an operating engine, has led to the use of this diagram as the criterion of the fuel-injection system's characteristics. A curve of this type which was obtained by an oscillograph is reproduced in Fig. 2.

Years of experience in developing the fuel-spray equipment shown in Fig. 3 has achieved manufacturing control of the fuel-injection apparatus. Engine performance, as related to lift characteristics, is transposed to dimensional and contour limits and calibration settings that control factory production of fuel pumps, fuel lines, and fuel-injection valves. Thus, these essential parts of the Diesel system are initially prepared at the source of manufacture to yield reproducible results in field performance by preserving predetermined fuel-feeding rates and atomizing characteristics.

The initial release of fuel from the single orifice in the flame plate of the injection nozzle starts the first phase of combustion in the precombustion chamber. The total period of combustion comprises three phases, namely, (*a*) ignition delay and ignition, (*b*) partial combustion and gasification in the precombustion chamber, and (*c*) subsequent final combustion in the main chamber. The delay period in precombustion-chamber engines is approaching the minimum value which cannot further be appreciably reduced by changes in compression ratio involving temperature, density, and turbulence within the confines of the precombustion chamber.

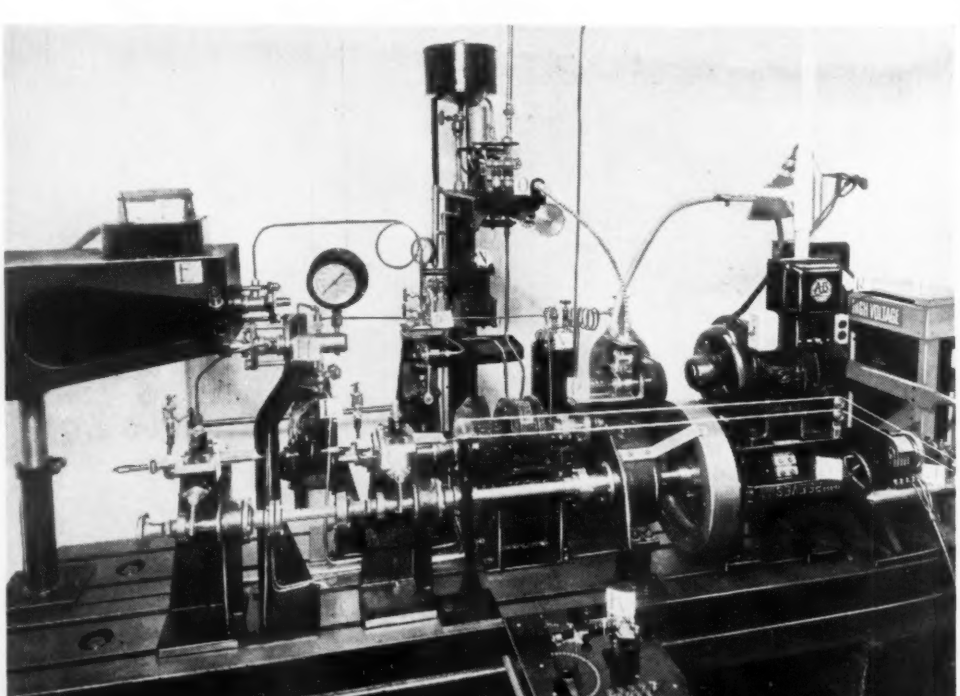

FIG. 3 MACHINE USED FOR DETERMINING FUEL-INJECTION CHARACTERISTICS AND SPRAY FORMATION

CONTROLLING COMBUSTION EFFICIENCY

The efficiency of combustion proper is primarily controlled by velocity and completeness of mixture formation. The velocity of the combustion itself, is controlled by the mechanical mixture of fuel and air, or turbulence. Optimum turbulence and most complete mixing generally require greater time than is usually available in high-speed engines. As expressed by Boerlage and Broeze (2), the task of forming a complete mixture is distributed between production of (*a*) a good micromixture by suitable atomization and (*b*) a good macromixture by fuel distribution and turbulence.

In the precombustion-chamber engine, good micromixture is obtained by the impinging of the single cone of atomized fuel in counterflow to highly heated air currents from the main combustion chamber. Then follows vaporization, ignition, partial combustion in the presence of a limited air supply, and the subsequent gasification of the remaining injected fuel. Macromixture in the main combustion chamber is accomplished by the return flow of high-velocity gases, carrying and dispersing products of the precombustion chamber into intimate union with the necessary equivalent of air for the completion of combustion in immediate availability for combustion. To obtain clean and complete combustion at high piston velocity, a high amount of mixing energy is justified. This is obtained in the precombustion-chamber engine by the proper design of the temperature envelope surrounding the combustion gases and the velocity-controlling passages through which the gases pass. With proper design and limit-controlled metal sections and contours, performance characteristics are predetermined for extended periods. Cleanliness and completion of combustion of a character eliminating carbon formations or lacquer depositions guarantees continuance of this predestined performance.

That combustion is effectively controlled by rapid mixture velocities is attested by the fact that a $3^3/_4$-in. bore, 1600-rpm engine shows completion of combustion at 80 lb brake mean effective pressure loading with a stroke represented by 60 deg of crank angle from top center. Under similar conditions, a 140-deg combustion period is not uncommon in many types of Diesel systems. The work of MacGregor and Hanley (3) indicates clearly the possibility of long service from correctly designed precombustion-chamber engines due to exceptional freedom from carbon formations. An engine, to survive long working time without overhaul, must be self-cleaning or relatively free from carbon- and lacquer-forming tendencies of combustion.

To maintain laboratory checks and records on production performance, the apparatus shown in Fig. 4 was developed. This four-unit oscillograph records photographically a card as shown in Fig. 5. Beginning at the top, the lines of this card are a timing wave with top-center interruptions, the fuel-injection valve-lift curve, the rate of pressure rise of combustion gases in the main chamber, and the pressure-time diagram. The essential performance-controlling factors are simultaneously recorded on a single photograph for record purposes. It is pertinent to note, in view of the foregoing discussion, the extremely short ignition lag and the comparative freedom from high-peak gas-pressure impacts in the combustion phase. By frequent laboratory checking of production quality, manufacturing limits and technique can be controlled to yield reproducible and uniform operating performance. It may be of interest here to quote an excerpt from the paper on "The Diesel Tractor and Excavator" of June, 1930 (1), wherein a statement from Dr. Neumann (4) is abstracted.

FIG. 4 FOUR-ELEMENT OSCILLOGRAPH DEVELOPED FOR ENGINE-PERFORMANCE RECORDS

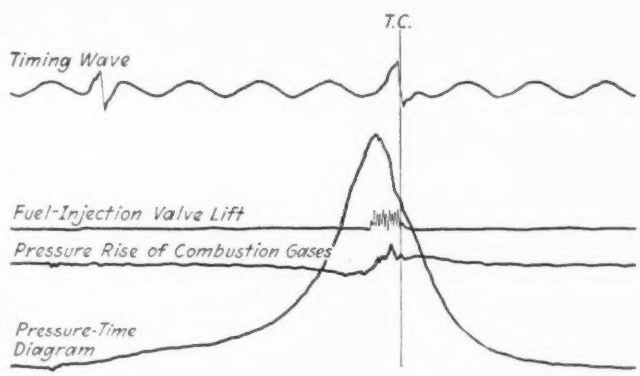

FIG. 5 DIAGRAM FROM THE FOUR-ELEMENT OSCILLOGRAPH

In the high-speed Diesel engine the precombustion-chamber process must be of advantage in the rapid heat transformation of the injected fuel by good distribution by means of high temperature and lively turbulence which may be obtained (in the engine) by simple means.

The more rapid the formation of gas follows the inception of ignition through the breaking up of the molecule, the faster will be the ensuing combustion and of less consideration will be the heat loss to the surrounding media. . . .

In the use of heavy oils with high ignition points and with high carbon content, the precombustion-chamber engine is superior . . . ; its surety of performance under severe service conditions is beyond question.

Ten years of continued experimentation and accumulated improvements as developed from a more comprehensive understanding of the fundamentals of the combustion process have further served to justify this prophecy, particularly as it applies to heavy-duty track-type Diesel-tractor service.

In the initial introduction of the Diesel engine to new fields

of service, it is apparently tempting for salesmen to stress its broad appetite for every description of available fuel. The native economy of the Diesel has been stressed to the point of consuming the most indigestible fuels. Today, this tendency is fast disappearing and we find that rational diets of fuel are prescribed, and maintenance records justify the general acceptance of this practice. The industry has been more reticent in adopting the same life-giving remedy in prescriptions for lubricants.

THE PROBLEM OF LUBRICATION

The lifeblood of motion is lubricating fluid, and, with service demands of a specialized character, it would seem to be wise to select suitable oils with as much scrutiny and analysis as is given steel or other highly developed materials destined for specific utility. Alloy steels are designed for definite service characteristics. So also are compounded lubricants blended to satisfy heavy-duty-service demands. The cry for low maintenance cost over long periods of operation is satisfied by compounded lubricants conceived and synthesized to meet a superior knowledge of the factors which are involved in Diesel lubrication. These factors are, essentially, (*a*) ring-sticking resistance, (*b*) compression-space sealing, (*c*) load-carrying capacity, and (*d*) heat-dissipating ability.

In track-type Diesel-tractor service, any given piston design must accommodate the heat flow through its sections as dictated by conditions that vary between the limits of (*a*) atmospheric temperatures from —60 to 130 F, (*b*) altitudes from 200 ft below sea level to 16,000 ft above, and (*c*) loading from no-load and variable load to continuous overloads. These extremes in service factors impose considerable variation in ring-belt temperature which taxes the ability of any lubricant to qualify for all conditions.

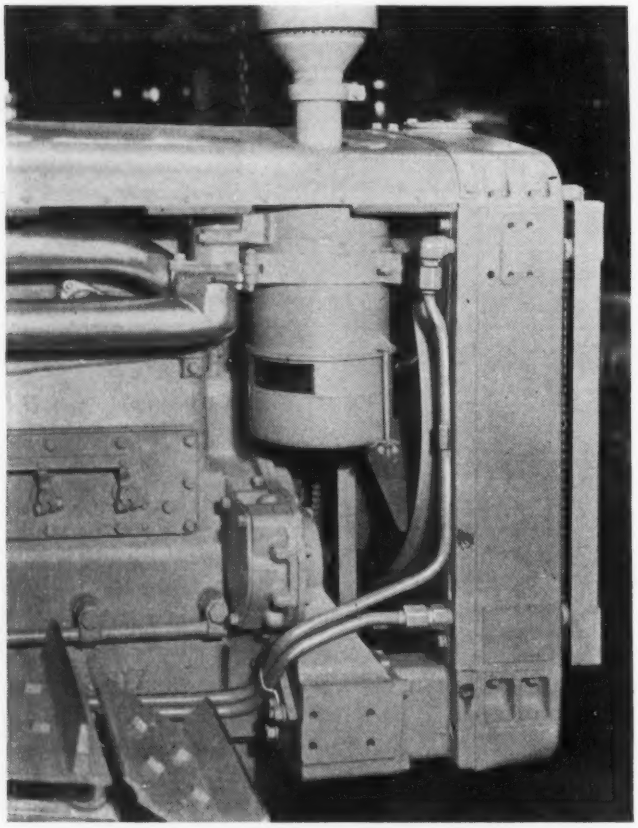

FIG. 6 DIESEL ENGINE FOR TRACK-TYPE TRACTOR SHOWING OIL-COOLER INSTALLATION

Considerable evidence (5, 6) has been presented to prove the influence of ring-belt temperatures on the formation of binder materials that cause ring sticking. Recently, experiments have shown that the oxyacids which are present in ring-binding depositions are only formed on heated surfaces coated with relatively thin films of lubricating oil. They are not formed in bulk volumes, such as in the crankcase sump, or in oil lines, oil filters, or oil flow channels. Their formation and deposition are, therefore, remote from the sphere of activity of any oil-purifying or oil-refining filter cartridge. Ring-belt clearances provide a most excellent location for the accumulation of such materials. Introduction of compounds to act as detergents against the lodging or attaching of these lacquers and binders to reciprocating or ring-sealing surfaces has been a potent factor in reducing maintenance costs and in lengthening periods of operation between overhauls. The practical solution for ring sticking for the wide variations of tractor service is in the lubricant and not in the use of a multiplicity of piston designs to suit individual conditions or involved designs of rings that remove the carbon and lacquer depositions by induced rubbing. These partial remedies never eliminate at the source the by-products of oxidation and polymerization in the lubricant under service conditions.

Free flow of an unconstrained compression ring over the oil film coating the cylinder walls is the best guarantee of maintaining a uniform compression ratio. This is vital in influencing the course of combustion and is of as much importance in modern Diesel practice as the static head of water supply is to a hydraulic-power unit. Continued sealing of the compression space against blowby of gases into the crankcase insures long life to the piston assembly, reduces wear of rings and liners to the minimum, and is of material assistance in preserving efficient lubricating-oil consumption.

At times, the Diesel process taxes the load-carrying capacity of the oil film to the limit of endurance. The air-fuel ratio in the Diesel engine is a lean mixture. The resulting oxidizing atmosphere calls for fortifying influences in the lubricating-oil film coating the cylinder walls. Means must be available in the lubricant to prevent the scratching or abrading of the cylinder wall in case of an emergency rupture of the oil film. Chemical treatment of cylinder surfaces and rings has insured safe break-in under accelerated loading and exhibited long operating-range effects in reducing ultimate cylinder and ring wear. Treatment of cylinder surfaces to establish oil-adhering properties, simulating by comparison a metal-blotter effect, is most effective in guarding against the drying of cylinder walls in periods of inactivity and the consequent dearth of lubricant upon subsequent starting.

Many track-type tractors are subjected to extremely dusty conditions. The Diesel motor must, therefore, be most effectively sealed against the inroads of dust and to prevent oil leakage to the outside. Such sealing does not permit the use of crankcase-ventilating methods. The smaller the engine, the nearer the bearings approach dimensionally the source of heat supply in the cylinder. The smaller the unit and the faster its operation, the more frequent the input of heat energy through the combustion system and the shorter the time element available for heat dissipation by radiation from the crankcase and oil sump. The sum total of these factors causes the rapid rise of bearing operating temperatures. As Diesel tractor engines become more compact in size, heat-dissipating surfaces grow less in area. Lack of ventilation imposed by service in heated atmospheres and reduction of heat-radiating surfaces resulting from compactness of design call for external means for dissi-

pating the heat removed from the bearing by cooling the circulating lubricating oil itself.

For the most economical fuel-burning operations, cylinder jackets are maintained at outflow at 175 F. Jacket water is unsatisfactory, therefore, as a cooling medium for the circulating oil in a tractor. A separate air-cooled radiator of the broad-surface fin type is, therefore, made available in front of the water radiator to cool the circulating oil well below critical temperatures for babbitt-bearing operation. This installation is evident in Fig. 6.

From all quarters, internal-combustion engineers issue the call for higher-duty bearing materials. The bottleneck in all types of present-day-engine development in the race for higher outputs, greater economies, and faster speeds is bearing material. Babbitt serves best wherever temperatures are held below critical values. The air-cooled oil radiator provides this insurance with life-lengthening extensions in operating hours to bearings. Not only is bearing life increased by cooling, but also, in high atmospheric-temperature operations, oil deterioration is considerably reduced and thickening influences offset, insuring freer flow characteristics in the bearing circulating system.

Lubrication of the connecting-rod bearings involves the correct balance of temperature dissipation over the bearing surfaces with respect to design, materials, and lubrication. Destructive influences on bearings are the combination of pressure and temperature concentrations on limited bearing areas. It is imperative that the intimate contour alignment between the bearing surface and the crankpin be preserved in operation, thereby maintaining a uniform flow of circulating-oil coolant. The combination of high unit pressure and temperature is responsible for babbitt cracking and bearing failure, but temperature alone can wield this destructive influence if sufficiently high, as illustrated in Fig. 7. The typical start of hairline cracks is evident, and these subsequently develop progressively inward until complete checking occurs.

Successful Diesel operation is insured by the careful balance in design of many small details of construction. The higher sustained maximum operating pressures occurring in the Diesel process demand freedom from distortions of heat-saturated parts. Reference has been made to the preservation of compression ratio by effective sealing by the lubricant. This presupposes designs that permit of round cylinders, pistons without proud surfaces, and rings of elastic conformity to cylinder surfaces. Mention has been made of connecting-rod bearing alignment to crankpins to prevent bearing failures. Such examples are instances cited to establish a general rule for throwing the weight of design into contour-conforming surfaces under heat saturation to yield long-lived operation under the higher unit-pressure loading.

FUEL REQUIREMENTS FOR LONG SERVICE

As stated previously, the advent of the Diesel engine into new fields has invariably fostered the tempting use of undesirable, though possibly cheap, hydrocarbons as fuels. Experience has dictated the wisdom of burning Diesel distillates for long-time low-maintenance operation in Diesel-tractor service. Some medium- and high-speed units may get by on fuels containing residuals, but performance can be seriously jeopardized under idling conditions in altitude operations. At high load output, they are bad actors. Evidence has shown (7) that heavy residuals can seriously disturb fuel-injection characteristics. The last portion of the charge injected becomes poorly atomized and finds entrance into the combustion chamber at a time when macromixture is difficult to obtain. The combustion period is considerably increased, and carbon depositions become accumulative.

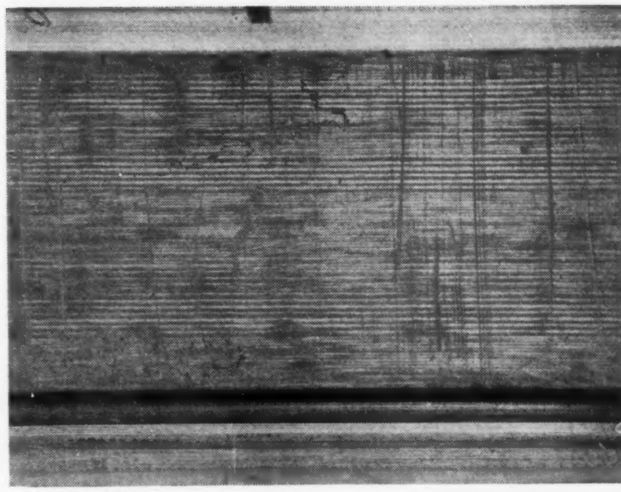

FIG. 7 TYPICAL CRACKS DEVELOPED IN BEARING METAL BY TEMPERATURE

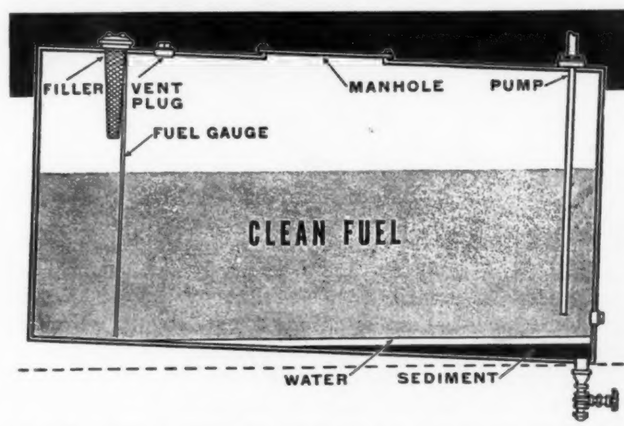

FIG. 8 SETTLING-TYPE STORAGE TANK FOR DIESEL-ENGINE FUEL

The first prerequisite of a good fuel for Diesel-tractor service would be a nonresidual fuel of suitable ignition quality which should be sufficiently high, permit the engine to start readily, and prevent missing under idling operation. Lacquer depositions from fuels improperly burned under missing conditions produce varnishes and gums that are detrimental to operation. Diesel fuels should, as a second requirement, be absolutely clean. When finished at the refinery, Diesel distillates are free from any contaminants. Storage and shipping permit opportunities for acquiring foreign matter that is highly abrasive to the injection system. Such materials as rust and zinc soaps from tanks are rated in first-rank position for destructiveness to fuel pumps. Dust, water, and polymer slimes have serious lapping properties, and clearances between the plungers and barrels are in hundred thousandths of an inch. The most damaging abrasive would, therefore, be of a size that bridges the gap between the plunger and barrel or equal to the thickness of the oil film. Such fine material is extremely difficult to filter out in mobile Diesel equipment. An excellent job can be accomplished by using settling methods. This has demonstrated itself conclusively on the basis of service records kept on fuel-injection equipment. A settling tank of the type illustrated in Fig. 8 has increased the length of service of fuel pumps and fuel-injection valves.

General availability of distillates for burner oils provides an excellent opportunity for petroleum merchandisers to utilize

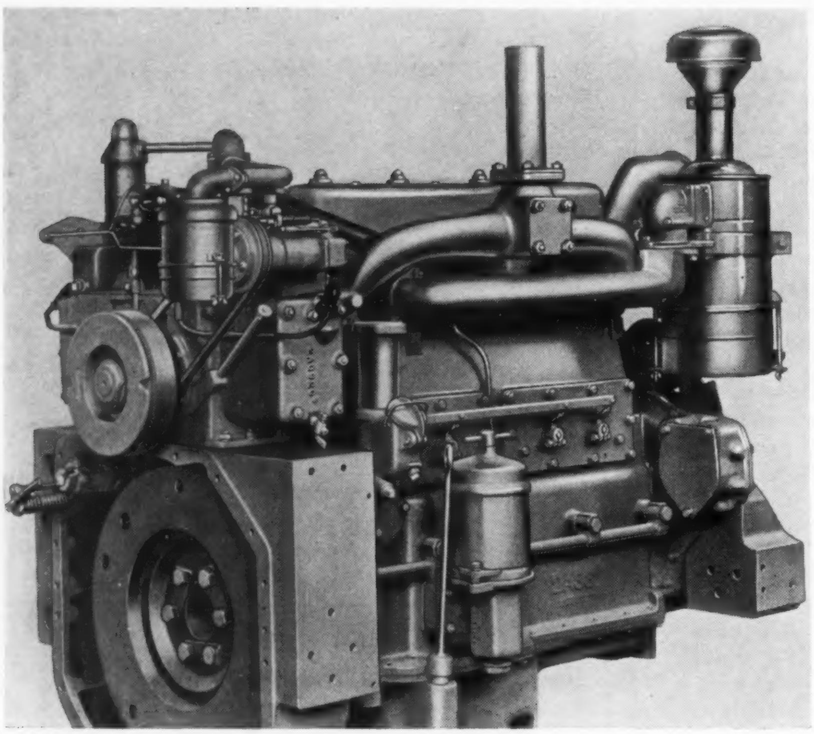

FIG. 9 TRACTOR DIESEL ENGINE SHOWING INSTALLATION OF AIR CLEANER AND ACCESSORY UNITS

this product for Diesel-tractor operation. A No. 3 furnace oil of suitable ignition quality and definitely clean and free from abrasives serves the majority of Diesel tractors. Cold-weather operation imposes a stipulation on pour point, otherwise the Diesel-fuel specification is simple in its structure.

Fuel-injection equipment, requiring manufacturing technique much finer than watchwork, is made to dimensions that are measurable in millionths of an inch and controlled in contours that are only discernible under the microscope. These parts, when assembled, function in an engine in operating cycles of a few thousandths of a second duration, and such equipment must be skillfully made and accurately calibrated to avoid the necessity of test-stand tuning or field adjustments. To take care of replacements in the field, each individual fuel pump and fuel valve is built up in replaceable assemblies. They are precalibrated and pretimed at the factory so that replacement is accomplished without the necessity for field timing or field adjustment. This service to the customer renders the extremely accurately manufactured fuel-injection equipment free from any performance disturbances upon installation or in operation, as no field adjustments are available to cause disturbances.

On the entire tractor Diesel engine, only three adjustments are at the disposal of the operator. These are the fan belt, the water-pump packing gland, and exhaust- and inlet-valve clearances. As a general rule, the fewer the adjustments found necessary for the stabilization of operating performance, the lower the maintenance cost. Adjustments invariably introduce equations with the personal element as the chief factor.

Tractor Diesel engines are required to perform heavy-duty burdens, mostly in dusty environments. The air cleaner is, therefore, a most important accessory. Its cleaning must be performed often to insure proper breathing of clean air by the engine. This cleaner, which is shown in the upper right corner of Fig. 9, provides three stages of air purification. A dry cleaner is placed at the inlet point of the induction system, and a heavy screen greets the initial flow of air and keeps out flying leaves and other large particles. In the lower part of this dry cleaner, the bulk of heavy material in the air is thrown out by centrifugal action, thus relieving the wet cleaner underneath of some duty. An accessible and removable oil pan gathers the fine dust collected by the oil-coated baffles placed above it. The dust is washed off the baffles and the oil films are restored by the swirling action of the air on the oil in the bath.

Inspection doors and removable covers provide accessibility for inspection and cleaning of the oil sump, oil filters, and breather. Only by making such vital inspection points readily accessible can reliance be placed in operating personnel for the proper servicing of equipment. The lubricating-oil filter prevents the entrance of foreign or abrasive material into the engine bearings; its function is one of protection rather than refining. No oil filter can restore, by means of filtration, the properties in a lubricant which were originally placed in it by the refiner. Clean appearance of a lubricant in service is no criterion for measuring the remaining service life of the used lubricant. After considerable work and experimentation, difficulty has been found in using the usual chemical and physical measuring sticks in ascertaining the remaining life factor of the lubricant. Certainly, color evaluation by ordinary visual means is the most uncertain micrometer. In tractor service, dust is ever the intruder, and frequent changes of oil insure the longest life values to the Diesel engine against the abrasive action of dust-contaminated oil circulation. Highly developed oil seals are most effective in dust exclusion from the engine crankcase but the induction of air and the piston pulsations may encourage the introduction of minute quantities of foreign material to the lubricant which accumulate with time.

Low maintenance is also assured by the design of parts so that wearing surfaces requiring replacement are broken down into small, relatively inexpensive units. Use of cylinder sleeves, valve structures, and replaceable fuel-injection-equipment assemblies, precision-type bearings, and similar refinements encourage low cost of replacement. The mechanical design of a tractor Diesel engine, balanced in detail to provide life-giving qualities, supports the operating balance sheet of the Diesel tractor in phenomenal records of economy.

1 "The Diesel-Engine Tractor and Excavator," by C. G. A. Rosen, Trans. A.S.M.E., vol. 53, 1931, paper OGP-53-3.

2 "Combustion Qualities of Diesel Fuel," by G. D. Boerlage and J. J. Broeze, *Industrial and Engineering Chemistry*, October, 1936, pp. 1229–1234.

3 "Diesel-Engine Deposits as Influenced by Fuel Types and Operating Conditions," by J. R. MacGregor and W. V. Hanley, *S.A.E. Journal*, February, 1938, p. 34.

4 "Untersuchungen an der Dieselmaschine," by Kurt Neumann, *Zeitschrift des Vereines deutscher Ingenieure*, Sept. 8, 1928, pp. 1241–1248.

5 "Engine Temperature as Affecting Lubrication and Ring Sticking," by C. G. A. Rosen, *S.A.E. Journal*, April, 1937, pp. 165–172.

6 "Lubricating Problems in Connection With High-Speed Diesel Engines," by C. G. A. Rosen, Trans. A.S.M.E., vol. 60, 1938, paper OGP-60-4, pp. 145–151.

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CRANE HOOKS

Reconditioning and Routine Inspection

By D. L. SMART

RESEARCH DEPARTMENT, THE DETROIT EDISON COMPANY

REHABILITATION of a major power plant by The Detroit Edison Company raised many interesting questions. One of these had to do with the ability of the existing turbine-room crane equipment to handle the heavier machines that were to be installed. The cranes themselves were of sufficient capacity, but the condition of the crane hooks was unknown. Therefore, a thorough investigation of the hooks was undertaken. As this soon revealed that some of the hooks might well be considered unsafe and because plans were already under way to install new and larger turbogenerators at another one of the company's power plants, the scope of the investigation was broadened to include both large and small hooks at all plants.

METHOD FOLLOWED IN THE INVESTIGATION

The first step, after removing the hooks from the crane equipment, consisted of sandblasting to remove the accumulation of paint and the original scale and then pickling to reveal any cracks. This was followed by a careful investigation under a magnifying glass. Unless the condition of the hook was such as to cause immediate scrapping, the cracks were ground out, the hardness was determined, and the hook was annealed. The purpose of annealing was to put the material into as ductile a condition as possible so that overloading would be revealed by a gradual yielding of the hook rather than by a sudden failure. In cases where the hooks were scrapped, the rough forgings for the replacement hooks were annealed, pickled, and carefully inspected for cracks prior to machining. Table 1 gives the schedule followed in annealing finished hooks and rough forgings. Machined and threaded shanks of finished hooks were protected from excessive oxidation during the annealing operation by packing them in fire clay surrounded by asbestos paper. Additional protection was secured by then placing the hooks in sand.

TABLE 1 ANNEALING SCHEDULE FOR FINISHED HOOKS AND ROUGH FORGINGS

Max thickness of hook, in.	Depth of packing box, in.: Finished hooks	Depth of packing box, in.: Rough forgings	Time to heat to 1650 F, hr: Finished hooks	Time to heat to 1650 F, hr: Rough forgings	Time held at 1650 F, hr: Finished hooks	Time held at 1650 F, hr: Rough forgings
8	14	Rough	24	8	18	6
7	12	forgings	20	7	16	5
6	10	annealed	16	6	12	4
5	10	without	16	5	10	3
4	8	packing	12	4	8	2
3	6		9	3	6	$1^1/_2$
2	6		9	$2^1/_2$	6	$1^1/_2$

NOTE: Large hooks, 4 to 8 in. thick, were cooled in the furnace to 1000 F and then removed and cooled in air. Small hooks, 2 to 3 in. thick, were removed from the furnace at 1650 F and cooled in air.

Rough forgings were machined after annealing, and both new and used hooks were cleaned by sandblasting. The hardness was determined, and, in a majority of cases, the hook was subjected to a proof-load test at rated load. If the hook gave evidence of being in satisfactory condition following this procedure and did not take an excessive permanent set during the test, it was placed in service. In a few cases, load-deflection tests were made before and after annealing, with interesting results. Several scrapped hooks were given repeated-load tests to determine the effect of repeated loading on the yield point. The results of these tests are discussed later.

FIG. 1 ONE OF THE HOOKS THAT WAS SCRAPPED AS A RESULT OF THE INVESTIGATION WHICH REVEALED NUMEROUS FORGING CRACKS

HOOKS TO BE GIVEN PERIODIC ROUTINE INSPECTIONS

As a result of the conditions revealed by this investigation, it was decided to make periodic routine examinations of all power-plant crane hooks. If the hooks were in constant use, as is the case in a steel mill, for example, a schedule could have been laid out requiring annealing at certain stated time intervals. Power-plant cranes, however, are used relatively infrequently and at irregular intervals. Rather than arbitrarily to require annealing at regular intervals regardless of use, it was decided to establish permanent reference stations for measuring the throat opening at the shortest distance between the point and shank of the hook and to measure this throat opening periodically to detect any permanent set due to loading during service. A method was developed for producing permanent reference stations for measuring the throat dimensions of crane hooks within limits of $\pm$ 0.002 in., and tentative limits were set for the minimum permanent set that would be allowed before the hooks were required to be annealed. These limits were 0.005 in. for hooks under 35 tons capacity and 0.010 in. for hooks of 35 tons capacity and over.

It was desired to produce reference stations with as little damage as possible to the surface of the hook and at the same time to make it possible to reproduce measurements over a period of several years' service. The method finally evolved

consisted of grinding a shallow ring-shaped groove in the surface of the hook and polishing the central core so that its surface was slightly below the original surface of the hook and its contour was such that reproducible readings could be made with inside micrometers (see Fig. 2).

A list of all hooks tested during this investigation, together with pertinent data concerning their condition before and after annealing, is given in Table 2. It is interesting to note that, of the 21 hooks originally tested, six were scrapped for one reason

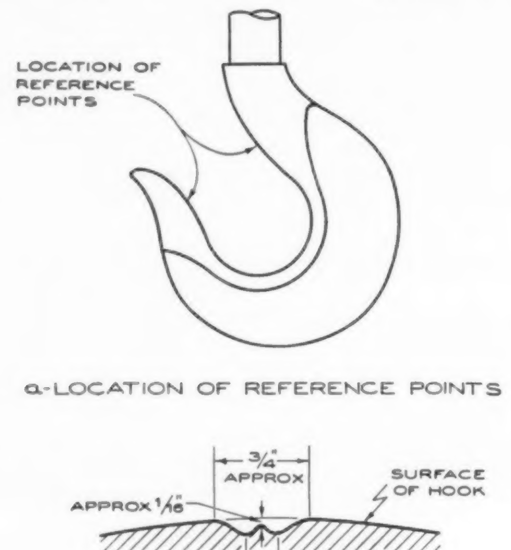

FIG. 2 LOCATION OF REFERENCE POINTS ON CRANE HOOK AND CROSS SECTION THROUGH REFERENCE POINT

or another. Fig. 1 is a photograph of one of the scrapped hooks showing numerous forging cracks.

HARDNESS READINGS INDICATE HOOKS LIKELIEST TO FAIL TO HOLD LOAD

The reduction in the Rockwell B hardness of the hooks due to annealing varied from 0 to 27 points and the final hardness after annealing varied from 43 to 76$^1/_2$ Rockwell B, with an average of 62. Results indicated that, although hardness tests are valuable in determining the effectiveness of the annealing, they are probably of greater importance in revealing hooks which, because of low carbon content, may not be able to hold their rated load after annealing. The effect of carbon content on hardness after annealing is clearly shown by the results obtained with three hooks on which carbon determinations were made. For hooks having carbon contents of 0.14, 0.38, and 0.40 per cent, hardness after annealing was, respectively, 43, 72, and 76$^1/_2$ Rockwell B. The importance of hardness tests as an indication of ability to hold rated load becomes apparent when it is noted, in Table 2, that the four hooks which failed to hold their rated load after annealing were those which were the softest after annealing. No hook with a hardness of 56 Rockwell B or over failed to hold its rated load, and no hook with a hardness of 52 Rockwell B or under was able to hold its rated load. It is believed that the failure of the four hooks to hold their rated load after annealing was due to a deficiency of carbon rather than to poor design or incorrect heat-treatment.

In the course of this investigation, a question arose as to the effect on the safe hook load of grinding out cracks at the critical section of the hook. Obviously, if cracks were present and the hook were to remain in service, it was essential to remove the cracks and eliminate the stress concentration which they produce. Some concern was expressed, however, regarding the possible reduction in load-carrying capacity caused by such a procedure. Mathematical calculations were made to determine, theoretically, the reduction of load necessary to maintain a constant stress at the critical sections of hooks of two cross-sectional shapes as increasing amounts of metal were removed from the inner surface at the critical section. Results of these calcula-

TABLE 2 RESULTS OF INVESTIGATION OF POWER-PLANT CRANE HOOKS

Hook no.	Hook capacity, tons	Rockwell B hardness Before annealing	Rockwell B hardness After annealing	Reduction of shank diameter due to scaling, in.	Permanent set due to application of rated load after annealing, in.	Remarks
1	125	...	...		0.0000	
2	125	83	72$^1/_2$		0.0000	Anal: C, 0.38%; Mn, 0.56%
3[a]	125	74	68		0.0000	
4	100	...	...	...	....	Scrapped due to large cracks
4[b]	100	...	56			Not proof-loaded
5	60	76$^1/_2$	67$^1/_2$			Not proof-loaded
6	35	81	71	0.003	0.0002	Set was 0.003 in. before annealing
7	35	74$^1/_2$	74$^1/_2$	0.003	0.0000	
8	25					Scrapped due to forging cracks and burned metal
8[b]	25	...	65	...	0.0009	
9	25	58$^1/_2$	51		0.0075	Still opening at rated load when test was stopped. Scrapped
9[b]	25	81	69$^1/_2$		0.0000	
10	25	85	69$^1/_2$	0.004	0.0000	Set was 0.0009 in. before annealing
11	25	58	56$^1/_2$	0 .003	0.0002	
12	15	62	52	0.001	0.0117	Continued to open under rated load. Scrapped
13	15	60	43	0.001	0.088	Anal: C, 0.14%; Mn, 0.53%. Continued to open under rated load. Scrapped
14	15	68$^1/_2$	49	0.002	0.029	Continued to open under load. Scrapped
15	10	69	57		0.0008	
16	10	77$^1/_2$	76$^1/_2$		0.0005	Anal: C, 0.40%; Mn, 0.65%
17	10	82	56	0.003	0.0006	
18	5	80	61		0.0009	
19	5	72	58	0.001	0.0011	
20	3	83	56	0.001	0.0003	
21	3	86	69	0.001	0.0004	

[a] This was a twin hook, and it was not possible to equalize the load at all times between the two arms. It is estimated that each arm was subjected to two thirds of the total load of 125 tons at different times during proof loading.

[b] Replacement for the original hook bearing the same number.

tions are shown graphically in Fig. 3. The dimensions were chosen for a hook of approximately 10 tons capacity, and the shapes were chosen because they represent the extreme limits of the usual trapezoidal hook section. The curves represent the loads required to produce stresses of 10,600 and 8900 lb per sq in. at the critical sections of the triangular and rectangular hooks, respectively, as various amounts of metal up to a depth of 1.08 in. were removed. If the rating of hooks of this size is conservative, it appears to be unnecessary to reduce the allowable load until between $^1/_4$ and $^1/_2$ in. of metal, depending on the cross-sectional shape of the hook, has been removed. It would have been desirable to have checked these calculations by photoelastic tests, but time was not available for such an investigation. Results of such an investigation would be of extreme interest both to purchasers and to users of crane equipment as a check on the effect of reducing the cross section by grinding and also on the validity of the hook formulas commonly used.

YIELD POINT LOWERED BY ANNEALING AND RAISED BY OVERLOADS

Several tests were made on scrapped hooks to determine, first, the effect of annealing on the yield point of the hook and,

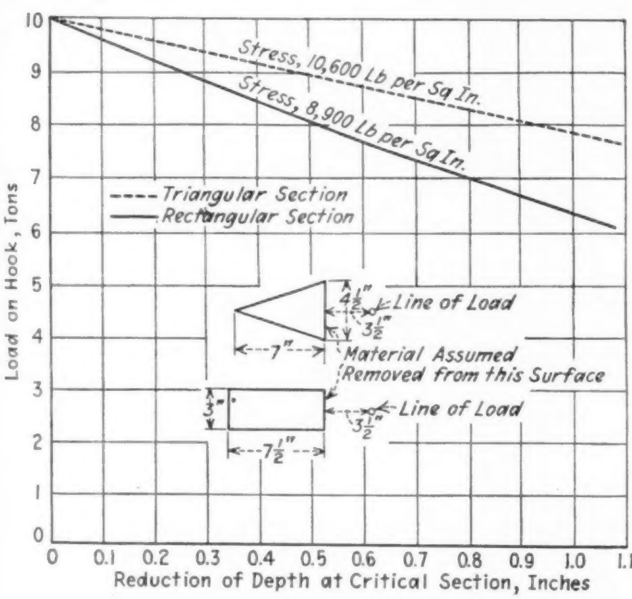

FIG. 3 REDUCTION OF LOAD NECESSARY TO MAINTAIN A CONSTANT STRESS AT CRITICAL SECTIONS OF CRANE HOOKS AS INCREASING VOLUMES OF METAL WERE REMOVED

second, the effect of repeated loadings on the yield point. Load-deformation curves for a 10- and a 25-ton hook are shown in Figs. 4 and 5, respectively. The deformations which are shown represent changes in the distance across the throat opening.

It will be seen from Fig. 4 that annealing lowered the yield point of a 10-ton hook by about 50 per cent. The hook tested had been in general warehouse service for about 17 years and just previous to the initial test it was loaded to 80,000 lb, under which load there was a permanent set of 0.4 in. in the throat opening. The hardness was $76^1/_2$ Rockwell B before annealing. No record was made of the hardness after annealing, but from results obtained with other hooks, it was assumed to be between 65 and 70 Rockwell B. Confirmation of the effect of annealing on the yield point was obtained from tests of a 25-ton crane hook that took a permanent set of 0.003 in. under a 25-ton load before annealing but continued to open under a 25-ton load after annealing. The hardness before and after annealing was $58^1/_2$ and 51 Rockwell B, respectively. This hook was scrapped because of its inability, after annealing, to hold its rated load without opening. As has been mentioned before in this article, it is believed that this hook had too low a carbon content.

Effect of increasing overloads on the yield point of a 25-ton hook is clearly shown by the curve in Fig. 5. During the series of tests represented by this curve, the yield point was raised more than 125 per cent. In general, the highest load reached represents the yield point for the next loading, provided that

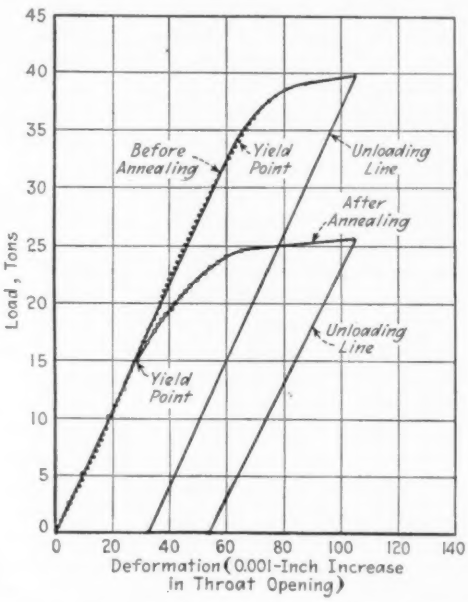

FIG. 4 LOAD-DEFORMATION CURVE FOR A 10-TON CRANE HOOK
(Annealing lowered the yield point approximately 50 per cent.)

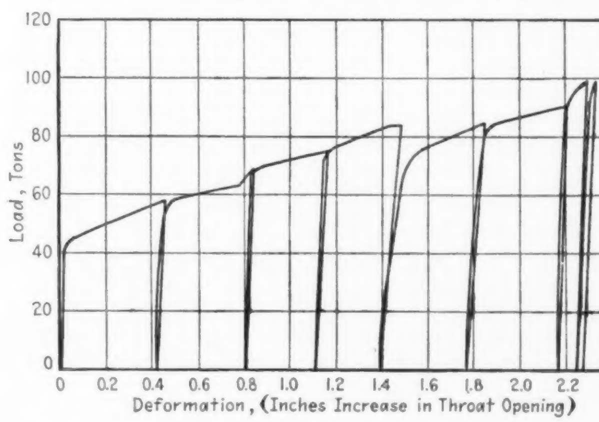

FIG. 5 LOAD-DEFORMATION CURVE FOR A 25-TON CRANE HOOK
(Effect of increasing overloads on the yield point is clearly shown. During this series of tests, the yield point was raised more than 125 per cent.)

this previous load was held long enough to allow most of the plastic deformation to take place. It will be noted that, in all except the last loading to 100 tons, the loading curves fall to the left of the previous unloading curve. This is due to the fact that because of certain peculiarities in the testing apparatus, a new hitch had to be taken after each few tenths of an

(Continued on page 624)

SMOKE-DENSITY MEASUREMENTS

By H. E. BUMGARDNER

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THIS PAPER describes a new method of measuring smoke density by indicators or recorders installed in a power plant. It is a development resulting from about seven years of experimental work with almost all the available types of smoke indicator and recorder. Although the method described was developed from tests carried out in two stoker-fired power plants of The Detroit Edison Company, it should give equally good results in pulverized-fuel-fired power plants if the equipment is installed on the outlet side of fly-ash separators and provided there is little or no more fly ash in the flue gas than in the case of the average stoker-fired plant.

The several commercial smoke indicators and recorders used in the experiments were installed precisely according to the recommendations of the manufacturers. For one reason or another, none of them was found to be satisfactory as a power-plant-operating instrument. In most cases the instruments themselves are satisfactory mechanically but inasmuch as only the concentration of the smoke and not the thickness of the smoke stream is taken into consideration in the measurement of smoke density, the records or indications obtained therefrom are not accurate.

Smoke density is used herein as referring to the quantity of smoke present in a section of a breeching or stack, and measurements are made by indicators or recorders employing a 0 to 100 per cent scale, 0 being no smoke and 100 per cent denoting black or dense smoke. Readings obtained from an indicator or recorder having light-source and light-sensitive units attached to opposite walls of a breeching or stack are affected by

(1) Smoke-stream thickness through which the device functions
(2) Proportions of transmitted, reflected, and absorbed light determined by the amount of smoke in the light path
(3) Reflected light from the surroundings, unless eliminated.

Item (1) may be readily demonstrated by taking an elliptical glass container and filling it with water to which a few drops of ink have been added and the mixture thoroughly stirred so as to give a uniformly but slightly colored mixture. If a lamp is placed on one side of the container and the light absorption measured or observed on the opposite side, first through the major and then through the minor axis, a large difference in the apparent density of the liquid will be noted although the unit density remains constant. The proportions of transmitted, reflected, and absorbed light in the light path vary with the smoke-stream thickness and with the concentration of the smoke. The inside of a breeching or stack is usually black, and light, other than that from the light source, ordinarily does not appear in the light path.

ORDINARY INTERNAL-ABSORPTION TYPE NOT SUITED

The ordinary, so-called internal-absorption type of instrument was found to be unsuited because the fact that the indicator readings obtained depend mainly upon the thickness of the smoke stream through which the light penetrates was not taken into consideration in its design and installation. If the light-source and light-sensitive units of an internal-absorption instrument are installed on opposite sides of breeching or stack walls that are 5 ft apart in one case and 10 ft apart in another, while the unit density remains constant, indicator readings in the two cases will differ considerably. This fact can be explained by reference to a scale that has been designed to take into account, or correct for, the variable thickness of smoke columns encountered in visual observations of smoke density at the stack discharge. This scale is fully described in part 20, Smoke-Density Determinations, of the supplement to the A.S.M.E. Power Test Codes which relates to Instruments and Apparatus. Briefly, it is presupposed that 20 per cent black or No. 1 smoke, according to the Ringelmann scale, applies only to a smoke column having a diameter or thickness of 5 ft, from which comparable values for other thicknesses and concentrations are developed as shown in Fig. 1. The complete scale then assumes the form given in Table 1. The variation of apparent smoke density with thickness of smoke stream and concentration follows what is known as an adaptation of Lambert's and Beers' laws.[1] Assuming that an ordinary internal-absorption type of instrument is installed in a 5-ft breeching and that the indicator reading of the smoke in the breeching is 20 per cent, Table 1 indicates that smoke of the same unit concentra-

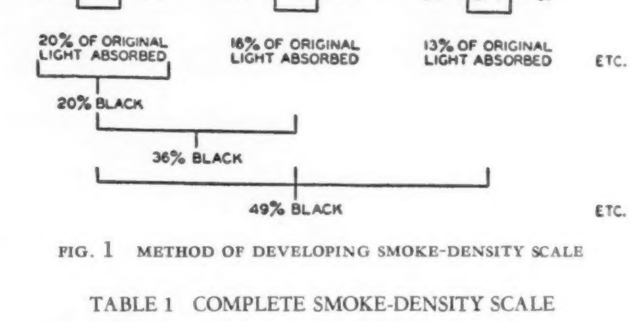

FIG. 1 METHOD OF DEVELOPING SMOKE-DENSITY SCALE

TABLE 1 COMPLETE SMOKE-DENSITY SCALE

Thickness of smoke stream, ft	Concentration, per cent No. 1	No. 2	No. 3	No. 4
5	20	36	49	59
10	36	59	74	83
15	49	74	87	93
20	59	83	93	97
25	67	89	96	99

tion will give an indicator reading of 36 per cent if the distance across the breeching is doubled or increased to 10 ft. This relation may readily be verified by obtaining four pieces of uniformly colored glass, preferably brown, of the same thickness. The percentage of light absorbed by one, two, three, and four thicknesses of glass stacked one upon the other and measured by a sight meter and a constant light source in a dark room will vary in the same ratio as indicated in Table 1.

In working with the various smoke indicators and recorders, the internal-absorption type which is perhaps one of the simplest smoke-measuring instruments used in power plants was found to be best adapted to the several necessary changes in design and installation. The arrangement of the ordinary internal-absorption instrument, in which a beam of light pass-

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[1] "Outlines of Theoretical Chemistry," by F. H. Getman and Farrington Daniels, sixth edition, John Wiley & Sons, Inc., New York, N. Y., 1931.

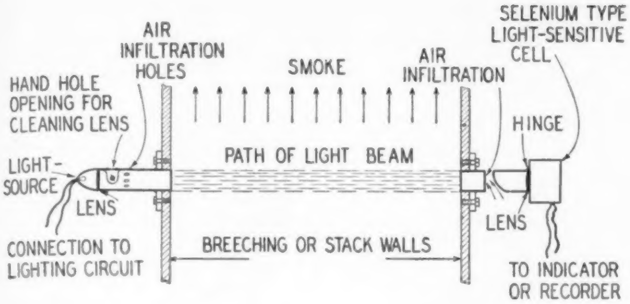

FIG. 2 GENERAL ARRANGEMENT OF ORDINARY INTERNAL-ABSORPTION TYPE OF SMOKE INDICATOR OR RECORDER

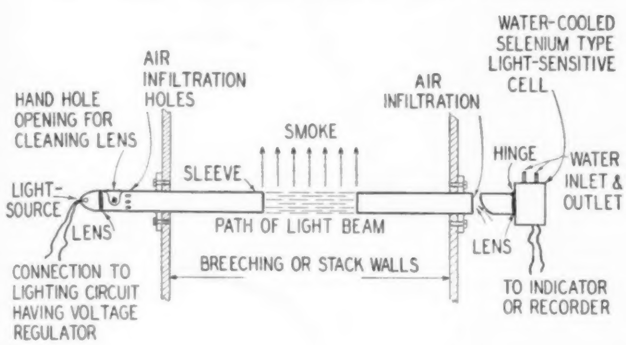

FIG. 3 GENERAL ARRANGEMENT OF IMPROVED INTERNAL-ABSORPTION TYPE OF SMOKE INDICATOR OR RECORDER

ing through the smoke in the breeching or stack falls upon the light-sensitive cell, is illustrated in Fig. 2. The quantity of light absorbed due to the smoke in the light path is an indication of the smoke density. As previously explained, assuming the same unit smoke density, such an instrument will indicate almost anything, depending upon the width of the breeching or the diameter of the stack in which it is installed.

The ordinary internal-absorption type of smoke indicator or recorder shown in Fig. 2 was found to be unsuited because

(1) Readings obtained are usually much higher than those which would be obtained by observations of the stack discharge

(2) Instrument could not be adjusted to give readings comparable with those which might be obtained at the stack discharge

(3) The intensity of the light source varied too much due to the voltage changes encountered

(4) Device could not be calibrated or checked (except by guess) while the boiler was in operation and smoke was being emitted

(5) The light-sensitive cell was subject to rapid deterioration if exposed to a temperature such as might easily obtain along the outside of breechings in hot weather.

The light-source and light-sensitive units of an ordinary internal-absorption instrument being attached to opposite walls of breechings or stacks of different cross sections, the readings obtained are not comparable with observations made of the stack discharge. Thus, for example, such an instrument installed in a 10-ft breeching will indicate a smoke density of over 70 per cent when the apparent density of the same smoke issuing from the stack, which is 16 ft in diameter, is under 40 per cent. It would seem desirable that indications from an indicator or recorder should be comparable with visual observations made of the stack discharge.

Fig. 3 shows the arrangement of the improved instrument which provides for all the necessary additions or changes to correct for these deficiencies. To have the indicator density reading and the observation of the stack discharge the same on a 0 to 100 per cent scale, it is necessary to reduce the effective thickness of the smoke stream in the breeching or stack to a relatively small distance. This is done by the calibrated sleeves shown in Fig. 3. The proper distance between sleeves required in any one case depends upon (1) the stack diameter and (2) the width of the breeching or stack in which the measurements are made. For the case of a 16-ft stack and a 7-ft breeching, the proper distance between sleeves was determined by test and found to be 21 in. When two boilers discharge into a single stack, the proper distance between sleeves is determined, of course, with only one boiler in operation.

The use of a small, definite smoke-stream thickness, such as the sleeves provide, was first suggested by Frank Sawford in a patent application[2] that was filed in 1927 and was described in a paper[3] that was presented at the Seattle Meeting of the A.S.M.E. later in the same year.

An internal-absorption type instrument which requires a constant light source should be provided with a voltage regulator if there is more than a slight fluctuation of voltage on the circuit. A change in voltage of even one volt will produce an appreciable change in the density reading.

With the sleeves, it is easy to eliminate the smoke in the light path and thus be able to calibrate the instrument while the boiler is smoking. This is accomplished either by disconnecting the light-source unit and inserting a slightly smaller pipe inside of the sleeves and across the opening between the sleeves or by providing a permanent shutter arrangement by which the gap between the sleeves may be opened and closed as desired. When all smoke in the light path has been eliminated in one of the ways indicated, the instrument may be calibrated or checked by the calibrated screens shown in Fig. 4. These

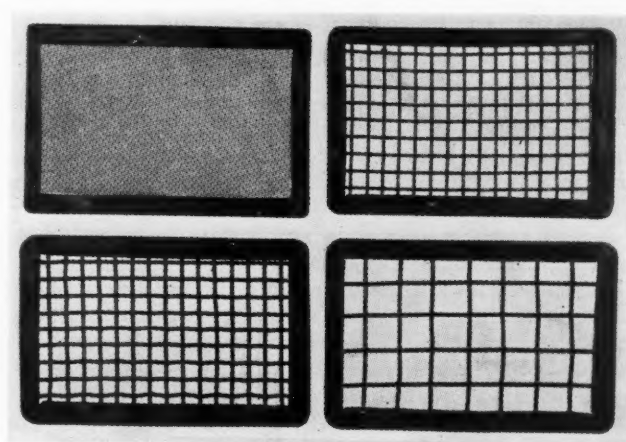

FIG. 4 CALIBRATION SCREENS

are inserted one at a time in front of the light-sensitive cell, and the reading of the indicator or recorder noted. If the instrument is out of adjustment, the intensity of the light source is varied by a rheostat. The four screens shown give four points on a 0 to 100 per cent scale.

The light-sensitive cell that is employed is of the type which will not withstand the higher temperatures sometimes encountered adjacent to the breeching. To prevent deterioration

[2] Patent No. 1,785,392 issued Dec. 16, 1930.

[3] "A Smoke-Density Meter," by Frank Sawford, Mechanical Engineering, September, 1927, pp. 999–1004.

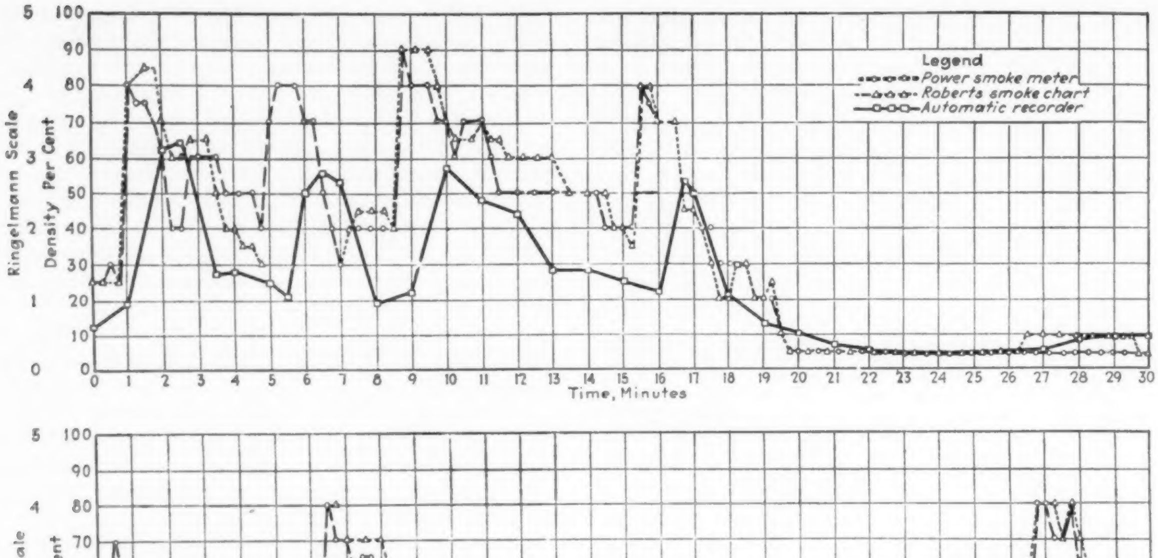

FIG. 5 SMOKE-DENSITY READINGS OBTAINED IN THREE DIFFERENT WAYS

due to temperature, the cell is encased on all sides except its face, so that it may be water-cooled. Compressed-air cooling in place of water cooling may be used, if desired.

The light source and the light-sensitive cell, which are each protected from dust deposits by lenses, are installed where the pressure within the duct is slightly below atmospheric, and the lenses are kept clean by air infiltration through openings in or into the sleeves as shown in Figs. 2 and 3. As an added precaution, however, the lenses are cleaned once during each 8-hr shift. Air infiltration through the openings keeps the sleeves free of all smoke without altering the thickness of the smoke stream between the ends of the sleeves.

The present installation in one of the plants consists of an indicator and a signal light, both of which respond to the change of current in the light-sensitive cell. The former is mounted adjacent to the breeching and is used for setting the signal light and for calibration. The latter is mounted on the boiler-operating floor where it can readily be observed by the operator. A single-point recorder could be added without any difficulty.

SMOKE-DENSITY OBSERVATIONS OF STACK DISCHARGE

In arriving at the proper spacing of the sleeves, smoke-density observations of the stack discharge were made. Such observations have to be made under more or less ideal weather and wind conditions regardless of what particular device is employed. None of the several methods of visually determining smoke density is without certain disadvantages. However, one of the several improved smoke charts based on a rational or 0 to 100 per cent scale was used and is preferred.

Smoke-density readings obtained simultaneously by using two different smoke charts in the hands of two observers and from one of the unsatisfactory recorders, are plotted in Fig. 5. A close agreement between the readings of both smoke charts will be noted, the largest variation being about 10 per cent. For test purposes, the boiler was made to produce black smoke in cycles as shown. This particular recording instrument had a time lag and, although it recorded correctly at lower densities, readings were low when the density exceeded about 30 per cent.

Any method of visual determination of smoke density which employs an irrational scale has the disadvantage that the readings obtained are not comparable with those obtained from indicators or recorders, all of which employ a rational or 0 to 100 per cent scale. In one instrument that employs an irrational scale, the range is limited and the instrument cannot be used for observations exceeding a relatively low density.

In the installation previously mentioned, the distance between the sleeves is such that the smoke-density readings obtained from the indicator and the observations of the stack discharge are the same. This scheme does not preclude corrections that might be made to the indicator readings to reduce them, for example, to what would be obtained if the distance between sleeves was some standard dimension, such as 1 ft. It seems desirable that any standards which might be agreed upon should provide for some correlation between the measurements obtained from indicators or recorders installed within a plant and observations made of the stack discharge. If corrections are applied, they should be made preferably after the indicator or recorder smoke-density readings and stack observations first have been obtained on a comparable basis.

In conclusion, the author is indebted to W. A. Carter, F. B. Goulait, and A. C. Pasini of the production department for assistance in the investigations.

INDUSTRY, LABOR, *and the* PUBLIC

A Contribution to the Better Public Understanding of Management's Several Relationships

By RAY M. HUDSON

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WHO LOSES when an industry closes its plant and moves away? The community!

Who loses when disrupted production stops the outflow of product? Everybody! The company loses business, the workers lose the wages they might have earned, the carriers lose freight revenue, merchants lose sales, banks lose savings that otherwise would have been deposited, and church collections dwindle. If the interruption continues long enough, even the tax collector does not collect as much as he otherwise would. If the trouble is bad enough, the community's reputation for maintaining law and order may suffer. In addition, the community may also lose the industry.

But why does anyone need to lose when a reasonable consideration of industry's obligations to us as customers, workers, stockholders, and citizens, and of ours to industry will provide a basis of mutual interest and understanding—the first essential to continuity of industrial residence and operation?

Manufacturing is such an important factor in the life of our nation and employment in manufacturing so necessary in the lives of millions of our people that some discussion of the several obligations of industry or of its management is not only timely in view of the current industrial situation, but is also necessary to a better public understanding of that situation.

The daily papers are full of reports of events or affairs in which someone's rights have been invaded, but seldom do those instances in which someone has fulfilled his obligations make front-page news. Finland made the front page for so doing, but that was some time ago. Perhaps the reason is that rights are an expression of self-interest. We naturally yell when our toes are stepped on. Our obligation, so to steer our course as to keep off the other fellow's toes, is taken for granted, but it often takes conscious well-directed effort to fulfill it. An obligation implies consideration of the other fellow. It makes us think of what we owe him.

In this article are outlined the obligations of management, industry's chief agent, to customers, workers, stockholders, and to the community of which all, including management itself, are essential members. What each of these owes to the others and what they all owe to management are also outlined, with the hope that more attention to obligations and less to rights will, at least, suggest a different approach to needed or desired readjustments.

It is said that out of its depression experiences, management has developed a new concept of its social obligations, or responsibilities. The fairly recent and rapid development of public-relations work by industry in its behalf demonstrates that industry desires to be better understood and appreciated for what it is, what it does, and what it means to the community and to the nation.

However, no amount of paid publicity or skillfully written advertising can offset unfavorable word-of-mouth comment that results from failure by industry to fulfill its obligations whether they are those to customers, workers, stockholders, or to the community. To acknowledge a responsibility is one thing; to live up to it is another.

What is meant by social responsibility? Does it mean a newly developed interest in matters long-considered no concern of management? Does it mean, as a result of that interest, an assumption of responsibility for conditions or situations not ordinarily considered within the province of management?

If we consider responsibility as "the state of being responsible or accountable," and also "that for which one is answerable, a duty, obligation, or a trust," then we may think of management's ordinary duties of supplying its customers with a sound product and its stockholders with a good return on their investments as its principal duties. However, when the word social is used to classify responsibility, we find that social means "pertaining to society, disposed to hold friendly intercourse, companionable, and constituted to live in society."

No extended study of management is necessary to demonstrate that it varies greatly in the degree of friendliness which it shows to stockholders, workers, customers, and to the community in which it "lives, moves, and has its being." Each industrial community has its good and bad examples. Similarly, in the history of nearly every industrial community can be found examples of the failure of one group or another to consider or to respect and live up to its obligations to one or more of the elements we are considering in this article. The reader as he checks the obligations herein stated will doubtless be able to call to mind instances which bear out this statement.

And now to the obligations themselves:

PART I

1 *Management's Obligations to Customers.*

(*a*) *To Give More for Less.* This is the philosophy of modern industry. The manufacturer makes his bid for sales on quality, quantity, and service at a price which the customer is able and willing to pay. The customer pays the bill, and therefore is entitled to value received at least, but business is finding that it pays to give the customer "value received plus," not as lagniappe but as an investment in good will that leads to repeat orders. When the customer is treated right, he usually responds and his continuing purchases of the same brand, make, or model show up in the reports of succeeding years.

To give this "plus" to value, management is obliged to keep its designs up to date, to improve its products through research, and to bring out new products. It is obliged also to keep its plant modern and equipped to produce goods better, quicker, and cheaper. It also has to keep its service up to date

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by maintaining high standards of accuracy, reliability, and courtesy.

(*b*) *To Stay in Business.* Customers have the right to expect that their sources of supply will be dependable. A firm which has won the customer's favor, as shown by his purchases, owes it to that customer to have the accepted product ready and available when he again comes into the market.

(*c*) *To Be Diligent in the Customer's Behalf.* The policy of caveat emptor was long ago replaced in progressive firms with the policy of looking out for or promoting the customer's interests. This requires management to be progressive not only as to policies, but also to conduct itself so that it does not provoke unfavorable public opinion, lose public sympathy, or invite regulatory legislation. It should not embarrass its customers, and in addition should always be honest, fair, frank, and open and aboveboard in all its dealings with them.

Progressive management seeks not only to hold present customers but annually to gain sufficient new ones at least to offset losses due to natural or unavoidable causes. It realizes that a minimum customer turnover may prove more essential to its success than a minimum labor turnover, desirable as that is. Progressive management also seeks to increase the number of its customers. Growth is not accidental. It must be planned and guided.

2 *Management's Obligations to Its Workers.*

(*a*) To pay them fair wages, and to establish and maintain mutually acceptable standards for the fair day's work that is the basis of a fair day's pay.

(*b*) To provide working conditions that assure the workers' safety, health, comfort, longevity, and peace of mind.

(*c*) To treat them equitably at all times, to discriminate against none of them, and to provide opportunity and means for them to express themselves to management on any matter which they feel or find is either favorable or adverse to their interests.

(*d*) To provide opportunity for advancement and at least to cooperate in their education and in their training for greater proficiency and larger responsibility.

(*e*) To provide steady work. Workers may work 40 hours per week, or 40 weeks a year but the costs of living for them and their families go on for 24 hours a day 365 days a year. Annual earnings mean more to most men than exorbitantly high hourly rates. A year-round job at a fair wage means security.

(*f*) To give credit where credit is due, and to recognize individual value and merit. Individual workers desire to be recognized and respected for what they do and what they are. The accurate worker desires his record of minimum spoilage and waste recognized and considered in the determining of his value to the company. Likewise the worker who, by his dexterity and other natural or acquired abilities, becomes known as a quantity producer desires recognition for his output performance. Again the worker who keeps his health, stays fit, and does not subject the company to losses of production through absences desires his regularity of attendance recognized.

A worker who has acquired several skills and is capable of performing several different jobs effectively desires his versatility recognized, for he feels that his value to the company is greater, other things being equal, than the worker of fewer abilities. While it has been demonstrated in any number of instances that mere length of residence on the job is no real proof of ability, length of service is often considered a criterion of ability and increasing value. The worker who has been with the organization a long time expects it to recognize the fact and to respect his seniority. And last but by no means least, the employee whose attitude is always cooperative, who is constructive in his endeavors, and whose conduct is right or exemplary expects some appreciation to be shown of his efforts.

Management, to fulfill its obligations to its workers, may well weigh these several factors and utilize all of them in its treatment of its workers, whether shop or office.

Beyond this, management owes it to its workers to keep them well informed as to its competitive position, its earnings, its prospects for continued operation, and other matters, ignorance of which often leads to suspicion, resentment, and interruption of operations. Sound employer-employee relations are as necessary to success as are either sound customer or sound public relations.

3 *Management's Obligations to Those Workers Employed by Suppliers or Vendors.*

(*a*) To make its purchases at prices that permit the vendor to stay in business, pay his workers a fair wage, and otherwise give to them relatively the same treatment and opportunities which the purchaser strives to give his own workers. The purchaser may well recognize that his supplier's employees are in a broad sense buyers of the goods and services which the purchaser's firm is offering.

While it is probable that the manufacturer who is working under fixed limits of cost will naturally try to purchase from the lowest responsible bidder, he should realize at the same time that excessive pressure for low purchase price may breed trouble in the vendor's plant and that this, in case of work stoppage or strike, rebounds to cripple the purchaser's operations. One of the first effects of the "sit-downs" was to curtail shipments from the vendor plants with consequent forced idleness as well as the loss of pay for many of the latter's employees.

(*b*) To maintain continuing relations with the vendor who lives up to his obligations in order that the latter's workers may also enjoy steady work, a fair annual income, and an abiding sense of security.

(*c*) To require reasonable production and delivery schedules to the end that the vendor's workers in their efforts to meet the purchaser's requirements may not be subjected to excessive strain or fatigue, and that the vendor himself may not be forced to make overtime payments or suffer other penalty costs.

4 *Obligations of Management to the Community.*

(*a*) To avoid pollution of air and water, commit no nuisances, or in other words, do nothing that makes or tends to make the community, because of the factory, less desirable as a place in which to live.

(*b*) To carry its fair share of the costs of community operation and services.

(*c*) To respect its responsibilities to the community. Establishment of an industry in a community imposes some obligation on the management of the industry to provide the fullest possible employment for its workers. The question may well be raised as to whether management has any moral right to dump workers on to the community, by reason of its inability to maintain steady operations, or by a lockout, or by removal to another location for any but the soundest of economic reasons.

(*d*) To conduct itself at all times in a manner worthy of the respect and cooperation of the community. Management may well maintain an interested, friendly, and cooperative attitude toward the community, cultivate and retain its good will, and

aid in its growth and development as a good town in which to live and work.

5 *Management's Obligations to Stockholders.*

(*a*) To provide them reasonable and regular returns on their investment.

(*b*) So to operate as to assure this without injury to customers, workers, or the community.

(*c*) To present to them accurate reports regarding the conditions and progress of the business and to do this at intervals which are sufficiently frequent to permit any needed corrective action as quickly as possible after the need for it is manifest.

PART II

1 *Customers' Obligations to Workers.*

Customers owe it to workers to order their requirements at the time or at a rate that will help workers to have steady work at fair and proper wages under right working conditions, and to achieve that degree of economic security essential to their welfare, progress, and satisfaction. Reasonable consideration by customers for those who build the product soon makes evident that minimum wage standards sufficient for healthful living put a floor under product prices. Pressures from workers' groups for higher wages tend to raise that floor while pressures from customers for lower prices operate to lower it. Customers owe it to workers not to press for prices that violate minimum living standards.

2 *Customers' Obligations to the Community.*

Customers may well realize that the community, in which is located the industry from which they purchase their requirements, makes certain contributions or renders certain services to the industry. These services are important factors in the continued successful operation of the business to which the customers look as a source of supply. Customer pressures for low prices may force management to transfer those pressures to the community in demands for lower taxes or abatements, or other concessions. These in turn may reduce the community's services to its industries.

3 *Customers' Obligations to Stockholders.*

It is not readily apparent that customers have any definite obligations to stockholders, although occasionally a customer may feel grateful toward those whose investment in a specific enterprise has helped to make available the goods and services which he, the customer, enjoys. For the most part, the greater obligation is from the stockholders to the customer.

4 *Obligations of Customers to One Another.*

These may exist though not easily definable. It is obvious that action by customers as a group may make or break a manufacturer, but such group actions usually find their origin in satisfaction or dissatisfaction with the product and the service behind it. Full freedom of choice in purchasing belongs to the customer, for when a dollar goes to market, it usually goes where it gets the fullest value. Customers are not obligated to continue purchasing a product or a line of goods which does not represent the fullest value for the price charged.

PART III

1 *Obligations of Workers to Customers.*

(*a*) Honest workmanship expressed in quality and quantity of daily product output.

(*b*) Minimum cost obtained through the elimination of the losses of time and material represented in spoiled work, and the loss of productive time represented in loafing on the job or stalling. While it is realized that some waste or loss is unavoidable, workers when spending their money for products do not wish to pay for wastes caused by the other fellow. Workers in the rôle of purchasers expect full value for their dollars. Therefore workers in the rôle of producers should give full value to customers.

(*c*) Avoidance of disruption of the service of supply. When customers find that they cannot get what they want due to the inability of the supplier to furnish them the goods as and when wanted, they look to other sources of supply. To the extent that customers of the company, which is unable to make delivery, establish and maintain satisfactory buying relations with another company, the first company loses business and its workers likewise lose work opportunities that, prior to the interruption, meant wages, buying power, and possibly job security to them.

2 *Obligations of Workers to the Community.*

(*a*) To be law-abiding and to cooperate with the authorities in maintaining law and order. Many recent illustrations of disregard for this obligation testify to increased costs to local, state, and national government for policing, arbitration, mediation, and court proceedings—costs which eventually have to be absorbed, chiefly by the taxpayers. Even those who do not consider themselves taxpayers, since they do not own property, pay a share of these greater costs in the prices of goods and services which they purchase. Taxes are not less burdensome simply because they are hidden.

(*b*) To maintain health, and to avoid accidents, fires, and other losses—for again costs to the community for services, protective or preventive, usually come to rest on the taxpayer's pocketbook.

(*c*) To be thrifty and self-supporting; to avoid becoming public charges. While it is realized that misfortune overtakes many, and the poor are always with us, both an obligation and a responsiblity rest on the individual to strive at all times to establish and maintain his economic independence. As for those who would "chisel" on their communities, nothing complimentary can be said.

(*d*) To be cooperative in community development and advancement, and in the protection of the community's good name. A town gets a poor reputation as a town in which to live when its citizens let it get that way.

3 *Obligations of Workers to Stockholders.*

(*a*) To respect their rights and interests and to show as much regard for the stockholder as the workers expect to be shown. It is the stockholder whose money sets the worker up in business, so to speak, by providing him with a shop or workplace where the worker labors and sells his services. The stockholder pays the taxes, insurance, and other upkeep costs for that workplace; provides and maintains the tools and machines, pays for the depreciation on them, replaces them when they become obsolete, and otherwise carries the burden of keeping the factory going. Without this aid, the worker, under our present economic system, is likely to be without a market for his services.

(*b*) Workers are not obligated to purchase the products of the company which employs them unless its products are within their desires and also their means to purchase them—and then only if and when the products have proved to be the best buy they can obtain for their money. Under these conditions it may be an evidence of enlightened self-interest on the part of the workers to cooperate both in building and maintaining sales for the company which employs them and for the

stockholders who have made its plant and facilities possible.

4 *Obligations of Workers to One Another.*

(*a*) To respect their rights as individuals without discrimination or coercion. Each one has his constitutional rights. Disregard or disrespect for them by the few works hardships on the many.

(*b*) To treat one another as each one desires to be treated. The golden rule is still the foundation of successful human relations.

(*c*) To stand together for justice, fair play, and right treatment, also for the protection of their standards.

PART IV

1 *Community's Obligations to Those Who Buy the Products of Its Industries.*

The community may well demonstrate to the customers of its industries, wherever those customers may be located, that it appreciates the business the community enjoys because of their purchases; and that the location and maintenance of these industries within its boundaries are to the advantage of the customers. In other words, show them that the specific location and the cooperation of the community with its industries, as expressed in public services and local attitude, are contributing to give the customer the fullest value possible.

2 *Community's Obligations to Workers in Its Industries.*

(*a*) To maintain conditions favorable to their health, safety, education, advancement, and general welfare.

(*b*) To stand by them when justice and fair play warrant or require.

(*c*) To stand against them when their demands and interests are against the best interests of the community, and thus against their own best interests.

3 *Community's Obligations to Stockholders.*

(*a*) To see that their property rights are respected.

(*b*) To show to stockholders some measure of appreciation for placing and continuing their investments in local enterprises.

4 *Community's Obligations to Itself.*

(*a*) To refrain from actions that cripple or handicap its industries or that are likely to render them less able to meet their competition, whether intraindustry, interindustry, or both.

(*b*) To exert itself to provide facilities and maintain conditions favorable to the profitable and continued operation of its industries, by avoiding excessive taxes or unduly restrictive or punitive ordinances or laws.

5 *Community's Obligation to Its Neighbors.*

To refrain from bribing their industries away from them or taking such other action as disrupts or tends to disrupt the neighbor community's economic situation, lest in so doing the aggressor community destroy purchasing power in the other community for the products of the former's industries.

PART V

1 *Obligations of Stockholders to Customers.*

To exercise such supervision over management as will assure customers, at all times, fullest value possible in their purchases.

2 *Obligations of Stockholders to Workers.*

Again, to exercise such supervision over management as will assure to the workers continuously all that they may have any reasonable right to expect in return for their services and contribution to the success of the product, as shown by its continued acceptance and purchase by the buying public.

3 *Obligations of Stockholders to the Community.*

(*a*) To accord to community officials and citizens a proper appreciation of the cooperation given by them in maintaining locally, conditions favorable to the continuance of the enterprise in the community.

(*b*) To exercise such supervision over management as may be needed to maintain mutually satisfactory relations between the community and its industries.

4 *Obligations of Stockholders to One Another.*

(*a*) To show confidence in and give support to able and progressive management.

(*b*) To maintain constant interest in the plant and its products as the sources of the returns which stockholders expect from their investment therein.

(*c*) To relieve themselves of management which fails to meet properly its obligations to all concerned, viz., customers, workers, stockholders, and the community.

PART VI

Obligations of Customers, Workers, Community, and Stockholders to Management.

(*a*) Customers owe to management, only that appreciation justly due for products well made and service well rendered, and this appreciation is usually shown by repeat orders for the product, and by expanding sales.

(*b*) Workers owe to management a cooperative attitude, fair play, and loyalty, as well as a fair day's work for a fair day's pay, when management fulfills its obligations to them.

(*c*) The community owes to management the protection of the property and other rights of those for whom management is the agent, custodian, or representative. It likewise owes management a fair opportunity to demonstrate its ability to manage; and also owes to management a measure of respect for its contribution to the community's success and progress.

(*d*) Stockholders owe to management their confidence, cooperation, and support, as well as a fair reward for its service. When management fails to meet its obligations properly to all with whom its task requires it to deal, stockholders should be prompt to replace that management.

PART VII

Management's Obligation to Itself.

(*a*) To establish and maintain high standards of efficiency and conduct.

(*b*) To demonstrate continuously its fitness for its job, through the results it produces, and by faithful fulfillment of its obligations.

(*c*) So to operate as to minimize the need for regulation or control by governmental agencies.

(*d*) Through its leadership to "point the way," to the end that the average level of management may be lifted continually closer to the level of that in the best managed plants. Management should never be satisfied with being average.

(*e*) To retire voluntarily from the scene of action when it finds it cannot live up to what is expected of it.

CONCLUSIONS

The net effect of an earnest effort on the part of each element—management, workers, stockholders, community, and custom-

(*Continued on page 626*)

New Electrical Equipment for
MANUFACTURING OPERATIONS

By W. D. TURNBULL

WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURGH PA.

TO SERVE the demands of industry, a motor manufacturer today must be able to furnish over 50,000 combinations of motors. In alternating-current motors alone, between 1 and 200 hp, there are over 20,000 combinations. Any one of these can be selected from the price form, and the motor manufacturer would be glad to accept your order and is set up to manufacture it. This is a bewildering figure and it is hard to understand that such a diversity is necessary to meet the requirements of industry, particularly when we realize that each and every one of those 20,000 motors is in some way distinctively different. For instance, a 1-hp motor may be furnished for 110, 220, 440, or 550 volts; frequencies of 25, 50, or 60 cycles; one, two, or three phases; high or normal torque requirements; various starting current requirements; in open, totally enclosed, totally enclosed fan-cooled, splash-proof, and explosion-proof types; and for foot, bracket, and flange mounting.

MANY NEW ELECTRICAL DEVICES ARE BASICALLY OLD

Now when we ask: What's new in electrical equipment for manufacturing operations? the answer is that new electrical developments are finding a place and useful purpose in industry by changing process and manufacturing methods and helping to produce a better product or decrease the cost of a product, but it usually takes some years to utilize or adapt a new basic development fully so that today many of our new and most useful electrical devices are basically old. Consider welding; basically, the art is not new as of today. However, an electronic timing device was recently developed. This device looks something like a radio tube but is several times larger. Its function is to control accurately the time that a predetermined current is permitted to flow through a circuit. Inherently, it is capable of handling several thousand amperes for a short time. Its development has opened up a whole new field and, in some industries, has completely changed manufacturing methods and designs. Briefly, this electronic device times and controls accurately the duration of a weld to $^1/_{120}$ sec so that thin steel is welded without warping, burning, or electrode marking on the exposed surface. Premachined mechanical parts are welded for accurate fit. As high as 120 fpm of continuous formed channel is being fabricated with 3-in-spaced spots, each the equivalent of a rivet. In the automobile industry, the combination of wide steel sheet, huge presses, and electric welding has produced the safest, cheapest, and best car that has yet been manufactured. The art of welding is not new. The electronic-tube timing device is new and, when applied to welding, enables industry to obtain a finer perfection of an older art or development.

Motors are not new, but there are adaptations, new mechanical and electrical modifications, to meet new requirements and problems of industry. For instance, we have commercial-aviation planes that maintain scheduled cruising speeds of over 200 mph and streamlined trains that maintain, day after day, speeds which only a few years ago were records in railroad history. One of the things that has made possible the manufacture of these trains and planes on a commercial basis is the machinery that consistently turns out the parts making up these planes and trains, with the precision that is necessary to stand up under these high speeds. What has the electrical equipment contributed in this development? New mechanical modifications have been made on motors so that they can be mounted directly on or near the tool, permitting higher speeds on the tool; more perfectly balanced motors have eliminated or minimized vibration; matched electrical characteristics give cushioned starting, synchronized speeds, and rapid reversals; and automatic control not only reduces set-up time but also consistently gives precision in operation. For instance, application of a modified variable-voltage drive to planers not only develops greater accuracy but also greatly extends the operating-speed range. Thus, the older form of drive would develop on a 4- to 5-in. stroke about 30 strokes per minute, while the new drive develops about 50 strokes per minute on the same length of stroke. The principal modification is the addition of a motor-generator regulator similar to that used in modern elevator control to maintain a constant speed for a given setting of the field rheostat regardless of load variation. This regulator also acts as a field-forcing means for the generator giving rapid acceleration and retardation of the motor and, therefore, fast reversal of the platen. Undoubtedly, this type of drive will find many applications in industry and is indicative of the trend in new control developments toward providing automatic operation, wider operating ranges, higher speeds, and greater accuracy with various parts interlocked to give protection to operator, machine, and work.

Looking back a minute at the motors, the electrical manufacturer is providing standardized designs with various electrical characteristics to meet almost every need of industry and mechanical modifications that enable the motor to operate safely in almost any surrounding. Totally enclosed fan-cooled motors develop practically the same rating as an equivalent size of open motor and, in addition, provide protection against weather, dirt, and metallic dust. Explosion-proof motors permit safe operation in surrounding atmospheres of explosive gases. Mechanical modifications, such as flange or bracket mountings, permit locating the motor directly on the machine or tool, or, in the case of a machine that is somewhat equal in size to the motor, such as a centrifugal pump, placing the pump directly on the motor, thus eliminating the bedplate, coupling, and pump bearing.

SOME ENTIRELY NEW BASIC DEVELOPMENTS

The "Precipitron," is a new electrical filter that cleans dirt, dust, and other foreign substances from air or gases by operating on the electrostatic principle. Even here, the idea of electric precipitation is not new but some basic modifications have opened up entirely new fields for the application of this cleaner. Its particular advantages are its high efficiency in a straight commercial design, and its ability to remove micro-

Presented at a meeting of the Machine Shop Practice Division, Rochester, N. Y., May 10–12, 1938, of The American Society of Mechanical Engineers.

scopic particles. For instance, a commercial design will remove dust particles down to $^1/_2$ micron in size and develop efficiencies over 90 per cent. It has already been applied in a number of industries and processes where dust or other foreign particles in the atmosphere present a problem in the manufacture of a product, like photographic and motion-picture films and certain operations in the textile industry. It has also been used in spray booths in pottery plants for recovering china glaze. Many other applications have been made, and new ones are being discovered continually. In addition to the industrial applications, it is being used in offices and homes for general cleaning. A small unit has been developed principally for use in sleeping rooms to give relief to sufferers from hay fever and dust asthma.

Another development is a new type of electric furnace for heat-treating dies in a pure gas atmosphere. The result is that the surface of the die is not oxidized or decarbonized, which means that the die can be machined or finished accurately, before it is heat-treated.

The "Sterilamp" is another new development. In appearance, the lamp is a long, slim tube faintly glowing with blue light. It emanates, by the passage of current through a special gas, a band of subvisible radiant energy which is sharply peaked in the germicidal band so that it is efficient in destroying microscopic life. To what extent this development will ultimately affect our lives is hard to predict. Applications are already being made in operating rooms to kill the bacteria in the air and reduce the possibility of infection. It has been applied in the preparation and packing of meat, foods, and allied products; sterilization of containers and wrappers for the prevention of contamination by fungi or molds; and in bakeries to destroy mold spores, thus increasing the length of time that bread can be kept fresh; and it has been found efficient in the sterilization of drinking glasses in public places, such as restaurants and taprooms. Time will develop where and how it will fit into our industrial activities, but it is likely that history wlil some day record its development as one of the most important contributions of electrical-engineering science to man. Years may be required before we fully appreciate and utilize these and other new developments. We like to feel that our scientists and research engineers are today working on the problems of tomorrow.

The "YOU" ATTITUDE *in* PUBLIC SPEAKING

By S. MARION TUCKER

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FARRELL almost invariably gets himself disliked by his audience. Some of us have investigated his case and found out why by asking a number of his auditors. He knows a good deal and really has much to say that is worth hearing. In some respects, too, he has a good technique. But he spoils it all by his excessive and only too obvious egotism. It sticks out all over him. Of course he has a right to feel just as egotistic as he likes, but certainly, as a speaker, he has no right to show it. But he *does* show it, not only by his entire attitude, suggesting his feeling of superiority, but also in the astonishing number of "I's" scattered thickly throughout his speech.

Now, the "I" used in a bit of honest autobiography, in a story, or in a piece of personal experience, and so forth, is of course not only quite harmless but is often most engaging. It takes the audience into the speaker's confidence, as it were—makes it one with him. But the "I" that simply asserts knowledge, opinion, or judgment must be used with delicate discretion. It is distinctly perilous. It is only too likely, if repeated very often, to sound egotistical and arrogant. It alienates the audience. It does not bridge the chasm between speaker and audience; it so widens and deepens that chasm that hardly any possible merits of the speech, hardly any use of adroit devices, can bring speaker and audience together.

The first phase of this "You technique," to employ a useful suggestive term, is the mere general attitude suggested by "You," even without use of the word. This may have little to do with actually uttering the words "I," "You," and "We." If the speaker really gets this fundamental mental attitude toward his audience, an attitude of equality and friendliness, he is not likely to use many offensive "I's." It is this deeply felt and clearly implied attitude of sharing that is most likely to win liking and interest. We recall Farrell's obvious and repellent egotism. Now, no matter how wise and superior Farrell may truly be, he is, after all, only human, like everybody down there in his audience. And how can he be sure that down there no one is his equal in wisdom? And even were he right in thinking that he knows more and is more important than anyone in his audience, why can't he simply acknowledge the fact to himself and yet be modest about it? After all, nobody knows much, even the wisest of us. Finally, if he just can't help feeling important, why hasn't he sense and grace enough to conceal his feeling? Whatever his other qualities, he certainly lacks any vestige of psychological insight, any idea of how to handle an audience. But the fact is that Farrell is self-satisfied in all his relations. Unfortunately, he simply takes his ordinary and offensive self up on the platform and exhibits it to all and sundry.

The other phase of the "You technique" is actually a matter of words. The friendly "You" attitude, felt within the speaker, is very likely to get itself expressed in the very *words* "You," "You and I," and "We." All serve the same purpose. Perhaps "You" may be said too often to an audience, but generally it is said far too seldom. Not the "You" that teachers use in talking down to a class. This hortatory "You," rather condescending and pedagogical, may prove as offensive as the most egotistic "I." Not the teacher's "You," by any means; but the "You" that communicates, makes common cause with the audience, and shares things with it. This friendly "You" carries a statement right home. It personalizes the statement. It helps to bring the audience right up on the platform with the speaker, or, better still, helps to take the speaker off his pedestal and place him right down on the floor with the audience. It is the audible verbal expression of the speaker's inner attitude. It helps to create an atmosphere of friendly receptivity. It is a major means of arousing and holding interest.

Sixth in a series of articles on the presentation of technical papers.

ENGINEERING'S PART *in the* DEVELOPMENT *of* CIVILIZATION

II—Civilization and Engineering at the Dawn of History: A Summary

By DUGALD C. JACKSON

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

. . . . prehistoric men, early in the Neolithic age, had crude pottery . . . .

(From La prehistoire orientale, Jacques de Morgan, Paris, 1927)

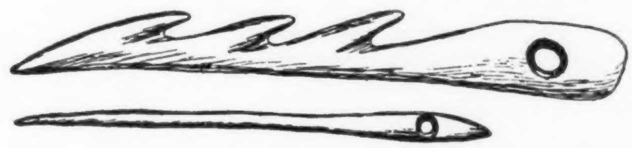
OUR SURVEY has now reached the period when human adventure has "culminated in the dawn of conscience and introduced the age of character," as the great Egyptologist Breasted put it. Civilization has begun. The addition of reflective mental effort to bring into a useful, coordinated structure the empirical and impulsive elements of artisanship has by this Dawn of History produced men competent to perform the functions of primitive engineers. Such men obviously must have been the individuals of most active mind and also of least willingness to bear the burdens of physical drudgery and wearisome watchfulness. These men guided people in general to means for living in greater assurance of life and greater convenience of surroundings by the expedient of gathering together in special communities; and with the communities arose customs which became the foundation for morals and ethics. Without the social contacts of community life, no soil exists for the growth of morals. With community life, morals and ethics become essential for existence.

Prehistoric men, early in the Neolithic age, had crude agriculture, crude pottery, crude weaving, and some domesticated animals. They had implements of stone and bone, and probably of wood, for tools and weapons; and late in the same age had finally come to some primitive metallurgy, so that copper, bronze and, in a few regions, some iron had come into service as the materials for tools and weapons. The production of metals from their ores was doubtless a matter of chance at first, but finally was the outcome of crude intellectual efforts in associating and coordinating separate elements into a workable process. Late in the Neolithic age man had come for safety to live a special community life in some areas, of which examples are the villages of lake dwellers with their coordinated structures borne on piles or cribwork, and villages located with hydrographic judgment on elevated regions in flood-scourged plains.

The profound influence which a developing agriculture had on the life of the prehistoric man may be illustrated by the usage of many existing primitive races, who name the natural seasons of the year in accordance with their relations to the normal weather and to planting and harvesting times. With the change from primary reliance for food on hunting and fishing, through a food supplement from agriculture, to primary reliance on agriculture and domesticated animals for food, the influence of the agricultural life gradually became intrenched, even though the agricultural people might be seasonally nomadic. The significance of this change was very great. Amongst other things, it meant some deliberation in planning food production in place of accepting solely those food sources which were provided by chance and the seasons. It also connotes some storage of imperishable foodstuffs to be utilized as a carry-over supply between seasons.

A suitable territory is capable of supporting a larger population of followers of agriculture than of hunters and fishers. Mutuality in the affairs of life then becomes more useful, the family unity becomes more integrated and communities are more likely to become established. The shift of conditions in each human age has made preparations for the next age, so that it is often difficult to distinguish the relative importance of inferentially influential features, such, for example, as the relative importance of inventions which have arisen in different ages. For illustration, to readers familiar with the cotton country: Which is the more important invention, the prehistoric invention of the eye-pierced needle (which is capable of being used with cotton thread) or the modern invention of the saw-toothed cotton gin?

Ethnologists tell us that a common language is not necessary



. . . . they had instruments of stone and bone—and probably of wood—for tools and weapons . . . .

(From Burkitt's "Our Early Ancestors," Macmillan Co., New York, 1926)

for family life and relations. I am not an expert on such matters and will not express myself on the soundness of this statement. Each reader can test it out by trying it on her husband or his wife. But, broadly speaking, a common language is of advantage for relations in a community of individuals, even though the individuals are few in number. The need for mutual language is particularly felt in the casual contacts of individuals which arise from commercial trade. Out of such needs the

Second of a series of six lectures on this subject delivered at the University of North Carolina State College of Agriculture and Engineering, Raleigh, N. C., Jan. 21 to 29, 1938. The first lecture was published in MECHANICAL ENGINEERING for July, 1938.

spoken languages of the world doubtless were developed. Organized language must have greatly facilitated and increased trade, and thus germs of ship engineering, harbor engineering and production engineering were fertilized to further growth by those who felt that advantage for themselves might be derivable from the growth of trade. Community concentration became greater at centers of trade, and demand for engineering structures and simple machines followed in the wake of community concentration.

While language was far from uniform at the stage of affairs characterizing the dawn of history, communities were individually of fair unity within themselves and the art of translation and interpretation of inscribed words had arisen. The powerful influence for unity of purpose which the ancient writers of Hebrew records believed would be commanded by the population of the world, were it in possession of a common language, is shown in the sixth chapter of Genesis in the Old Testament: "And the whole earth was of one language and of one speech. . . . . And the Lord said, 'Behold the people is one, and they have all one language; and this they begin to do (i.e., building a city and a tower), and now nothing will be restrained from them, which they have imagined to do. Go to, let us go down, and there confound their language, that they may not understand one another's speech.' "

Tools and simple weapons are evidences of artisanship, as also are crude pottery, weaving, simple agriculture, and some domestication of animals; but the trail of rudimentary structures, foresighted judgment regarding desirable village locations, and planned metallurgy (such as the bringing together of copper and tin to make bronze), which trail may be perceived as the dawn of history is approached, is a pathway in the development of engineering, i.e., the use of the mind to bring together physical elements into a coordinate whole (such as a structure or process) for the convenience of man. Add complex machines to these other features, as is ultimately done in engineering, and we will have stepped far.

EMPHASIS ON SEQUENCE

Let us emphasize the sequence. It was rudimentary engineering, evolved by the mentally most-alert who were reluctant to bear the physical burdens of a groveling life, that showed the way into the conditions of community life. Then, ethics and morals began a growth out of the consequences of the society relations. The ability for invention may have existed in a brain developed to the order possessed by early Neolithic man, but sufficiently sharp recognition of keen inconveniences may not have chanced to impress itself on his sluggish mind in a manner that caused him to exercise it on the effort to make complex improvements. However, as the Neolithic age advanced, the numbers of people in various parts of the world had become considerable and hand weapons were reasonably effective. In this state of affairs the insecurity of life and property was appalling, according to our standards, and it was difficult even from the then standpoint. Hence the mentally alert felt a call to the invention of means to relieve the pressure for great physical activity which was needed for maintaining life security and for securing food and shelter in the competition.

Thereupon inventions of structures, processes or simple machines arose from application of various minds to conceiving measures for modifying an existing situation, or creating a new one which was conceived to be better. The practice of invention obviously is subsequent in time to the development of reasoning powers in man. It is precedent to or coordinate with the application of mind to social organization which arises out of the conditions associated with community living. Social organization therefore proceeds hand-in-hand with scientific discovery and invention made useful by engineering, because engineering renders community life practicable.

Invention also involves experimentation by which the conception is built up into a physical embodiment, and it calls for a good deal of mental concentration. Moreover, it involves the intellectual courage to try again when a first embodiment has failed, and to try still again and again if need be after thoroughly reviewing and verifying the reasonableness of the conception.

With the main stem of the present human race reaching back a quarter of a million years or more, and brain volume as large as modern man's going back at least some tens of thousands of years, as anthropologists assert, there has been a long time for the more mentally active men who hated inconvenience to exert themselves in invention; but the early steps were founded on little experience and were extremely crude. Full stride has been reached only in recent centuries. But through it all, the inventors of these improvements used intelligence to save exertion of muscles, which is a practice that, in a more heterogeneous situation, we still follow in the present day.

Each step forward in the progress of invention looking toward security of life and property for prehistoric man gave further impetus to the tendency toward community living, which forced a growing respect for simple mutual interests. However, it was only after the stimulus for making inventions had resulted in an easier life with respect to life security, food and shelter, and also had released more time for cultivating physical ease, that growing ethical relations between man and man and tribe and tribe became strongly evident and community living became smoother.

Thus the growth of civilization went (and still goes) hand-in-hand with adventure of the mind in inventions. Civilization connotes harmonious cooperation of many human beings and also mutually sympathetic, helpful, and elevated relationships. It expands with the engineering arts because the latter enable groups of people to become closely associated for the purpose of securing their safety and ease of living without sacrificing either convenience or major comforts; and the close association leads to a growth of morals and ethics because social contacts show to each individual that rules and customs in the nature of ethics and morals are of service to the community and to the individuals composing it.

While their ethical propositions often are bound closely with their religion by the peoples of organized communities, it is not necessary for us to here consider the religious feature, because like ethics may associate themselves with diverse religions or ethics may be accepted regardless of the religion embraced by a person. The ethics arise from community mutuality, while religion may have as much force on one individual alone as on many. The ethical structures among the peoples of the world are the results of human instinct coupled with human experience relating to human contacts. Such structures may be independent of the religions of the peoples concerned, for example, as set out in the Confucian ethics so widely accepted in China; or they may be strongly influenced by the impact of religious traditions, for example, as set out by the Japanese under the influence of Shintoism. We also see intereffects, as in the alteration of pre-Christian ethics by the influence of the doctrines of Christ, with which changes we in the western world are familiar. Nevertheless, it is to be remarked that the desirability of associating the religious life with the secular ethical life is nowhere herein questioned.

Maintaining safety of life, equally against the inroads of wild animals and fellow men, prior to this epoch at the dawn of history, depended on use of the club, the knife, the spear, the sword, and the bow. Tribes were exterminated by other tribes,

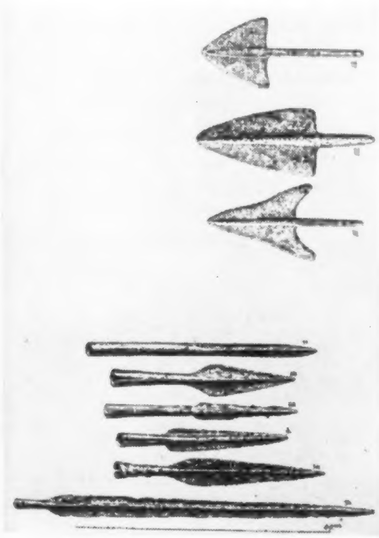
and the latter seized the hunting grounds, fishing grounds, and living places of the exterminated. With few exceptions, the contacts were between individuals or between savage and uncivilized hordes. Where (as in the lake villages) community relations existed amongst prehistoric peoples, it was still on the basis of a tooth-for-a-tooth, an eye-for-an-eye, a life-for-a-life relation. Bear in mind that engineering was only rudimentary at the dawning of history, and neither ethics nor morals were yet well established. They were only germinating.

THE INTRODUCTION OF METAL

During the sequence of centuries of the prehistoric era, each of these weapons (the club, knife, spear, sword, and bow) gradually became more refined in quality and more effective in service in some territorial areas, while similar progress had not appeared in other areas. The introduction of metals aided such progress. A bronze or iron spearhead may be more effective than one of chipped or ground (polished) stone, when wielded by equally vigorous muscles. Some traveling about, accompanied by interchange of some goods, had apparently become not unusual by the dawn of history—or how account for bronze? This is an alloy of copper and tin and the easily available ores of these metals do not occur contiguously.

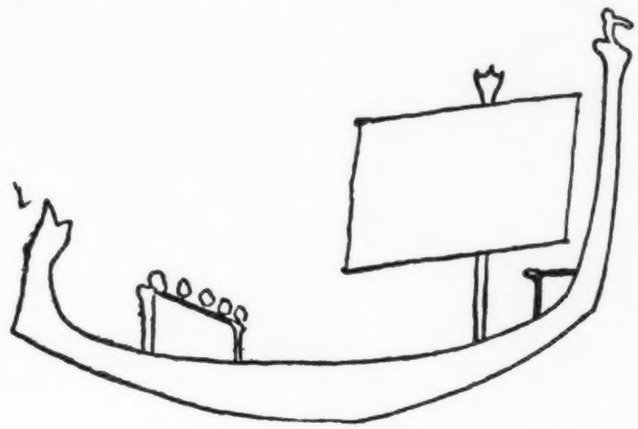
In early ages even slight contacts by means of hunters, wanderers, and adventurous traders resulted in the exchange of serviceable information; and also probably resulted in dissemination among backward tribes of improved implements of kinds which were in the possession of peoples elsewhere. Another force for spread of inventions seems also to have been in evidence in early days, as it is in evidence even in these days. That is, when two distant and alien peoples grew in organization simultaneously but without contact with each other, the urge for convenience sometimes resulted in simultaneous inventions of equivalent natures. Ambition and craving for convenience seem to sow the world atmosphere with ideas which simultaneously may be reached after in different quarters of the globe.

Bronze goes back perhaps six thousand years from our century, copper having earlier come into sparing use by man in some districts. But bronze, with its better qualities for weapons and for some utensils, seems to have replaced copper rather generally where a metal came into use in this early period. After copper, came iron. It is thought to have come into small use in Egypt as long as 5500 to 6000 years ago, and acquaintance with it and its serviceable qualities traveled into and over Europe slowly.



. . . . a bronze or iron spear head may be more effective than one of chipped or ground stone, when wielded by equally vigorous muscles . . . .
(From La prehistoire orientale, Jacques de Morgan, Paris, 1927)

For an understanding of the details of man's life in the times prior to the meager earliest inscriptions, we must depend on inferences gained from the character and locations of the artifacts left in enduring materials by the human beings and from human bones or parts of bones (with here and there a skeleton), bones of wild animals, remains of shellfish, cereal grains, remains of works (such as drawings on cave walls, burial mounds, piling of pile dwellings), and other such articles which were of durable materials or which nature has chanced to preserve. Relics of prehistoric boats have been found in the mud under the ruins of Swiss prehistoric lake villages, and perhaps elsewhere. There is good reason to depend on the inferences. They verify each other, and new discoveries are confirmatory.



. . . . for an understanding of the details of man's life in times prior to the meager earliest inscriptions, we must depend on inferences gained from the character of the artifacts left in enduring materials by human beings . . . . or on crude drawings . . . .
(From "The Sailing Ship," by R. C. Anderson, McBride & Co., New York)

The situation is a bit analogous to the case of the ruralite who found a lost horse by reflecting on what he would do and where he would go if he were a horse. The archaeologist must examine and classify all the prehistoric finds, then try to free his mind from all of the influences, conventions, and prejudices which have been implanted in his consciousness by his own modern experiences, and interpret the past with his mind open to be affected only by phenomena of the past. Thereupon, from his collection of prehistoric facts, he can draw wise inferences about the details of prehistoric living. This is a difficult intellectual achievement and many an ardent archaeologist has gone deeply into error because of his failure to eradicate from his reasoning all influences of modern knowledge. I may add that this correct procedure derives some justification from the fact, as we are told by physiologists and anthropologists, that the brain betterment of man is almost immeasurably slow. Therefore, if we can divest ourselves of modern knowledge and prejudices we ought to think in a manner somewhat like the prehistoric ancestors.

THE ENGINEERED VILLAGE

Then we arrive at inferences such as the following: For those inhabitants who became dwellers in engineered villages—for example, the villages of lake dwellers—the appeal and the practicability of permanent residence became established. Such inhabitants ceased a life of nomadism. This perhaps was partly because a wise location made the food supply of reasonable certainty. Also, the engineered village afforded more satisfactory protection from the elements than cave dwellings or a haphazard camp location or a nomadic life. Thus the roving ways of the hunter who depends mostly on wild meat for food gave way to more intensive thoughts of agriculture, among the inhabitants of the engineered villages. Man then had begun to

. . . . the engineered village afforded more satisfactory protection from the elements than cave dwellings or a haphazard camp location. Reconstructed lake village Uhldingen, Lake Constance, Germany.

(From "Human Origins," by G. G. McCurdy, D. Appleton & Co., New York, 1926)

capitalize his craving for security which has grown to great scope by this twentieth century. As a Chinese apothegm of 2500 years ago says:

> "The tree big as a man's embrace began as a tiny sprout,
> The tower nine storeys high began with a heap of earth,
> The journey of a thousand leagues began with what was under the feet."

The development of twentieth-century man has been a case of polishing the human being through hard trials, like polishing a gem by rubbing, and the process is not completed yet. Conditions amongst men in the prehistoric ages and the earlier milleniums of history, and man's ways of securing his life and a living, as far as we can know and conceive them, leave the impression that man's world in prehistoric days was, to use the words of Kingsley, "A God-forsaken anteroom of hell," when looked at from the vantage point of our modern comfort.

We do better now, in this twentieth century, but we are not through improving yet. A Chinese proverb says: "Intoxication is not the wine's fault, but the man's." And if we are not in this twentieth century making the progress that we ought to be making, it is for us to examine our own souls.

We will return to this question in a later lecture; but here I will note that pessimism regarding the state of civilization is not new. Mencius, who lived 300 years before the Christian era, wrote that the world had fallen into decay and that right principles had dwindled away; and doubt of civilization has been expressed over and over again by impatient philosophers during all of the Christian era.

The early aims of each human being seem to have included security (i.e., safety to life and limb, food, shelter from the elements) for himself and family such as characterize the objectives of most mammalian animals. In this we must recognize the difference between the aspirations of males and females, which is emphasized in the human beings. Then he gradually came to desire the permanent establishment of health, recreation, and contentment (or perhaps the correct word instead of contentment would be happiness). When imposture, deceit, and malice imposed themselves on mankind the sources of the deadly differences and hates of men were born, and this probably was synchronous with the early dawn of intelligence and therefore was tens of thousands of years before the dawn of history. The unhappy effects are with us until this day.

However, as far as the structure of social justice is concerned, although it is not yet fully practiced, it is nevertheless a component part of civilization because it arises from the results of social contacts. Puny steps in the establishment of social justice occurred even in the early part of the historical period of man. We still struggle with its problems. As Breasted, among others, has pointed out: "civilization in its broadest aspects is the product of a long social evolution." In this he is referring to wider interests than the purely material features of civilization. Even the high respect in which, in the western world, we hold "weak woman" is exclusively modern.

THE MEANING OF SECURITY

We now come to the question of what, considered broadly, is the meaning to the individual and the community of "security," previously referred to. Each individual in himself is a universe of happiness and misery. Which of these qualities gains the ascendant in any individual depends partly on the individual's environment and partly on his own intellectual force and adaptation which are his by heredity. "I observe only how men plague themselves," says the German poet Goethe, and this plaguing of themselves seems to have been a characteristic of man individually and collectively not only in modern times, but also in prehistory and the intervening period

. . . . nature finally provided . . . intellectual planning for the purpose of bringing certain of the simple elements of artisanship into coordinated structures . . . .

(From Tyler's "The New Stone Age in Europe," Charles Scribner's Sons, New York, 1921)

down to our own times. The answer to our question about the meaning of security is threefold, for the individual, for the individual's community, for the individual's nation; but the three parts merge into one whole on account of the individual.

Interpreted in terms of our present life: For the individual it means, in addition to security against violent death, an opportunity to do some productive work without interruption and in happiness; it further means an opportunity to provide for one's family in moderate plenty; it means to protect health, provide schooling for the children, recreation for all; it means a sense of assurance that sufficiency of food, clothing, shelter may always be available; it means sympathetic associates and neighbors.

For the community it means much the same as for the individual, provided we use the words of the statement in a collective connotation. It means in addition thereto, organized measures for supplying mutually developed needs (such as water supply, waste disposal and organized transportation), measures for combating emergencies such as fires and for restraining unruly or unfair individuals, provisions for adjudicating differences between individuals or between the community and individuals.

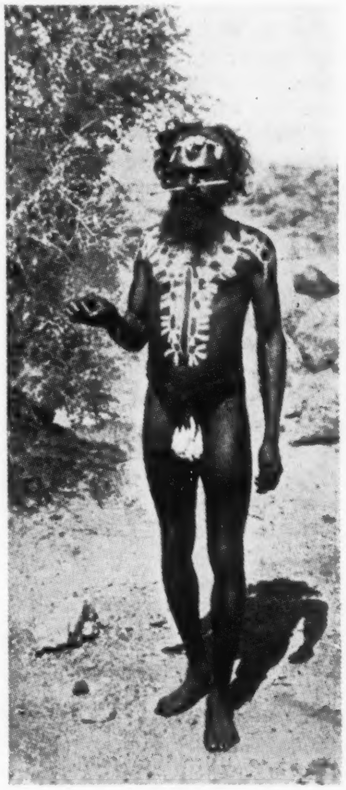
For the nations it has different connotations because of the differing characters of contacts within different nations, differing ideals of men who are alien to each other, and the reduced sympathy between such. In any one nation it means much the same as for the community but with additional provisions for adjudicating differences, especially between community and community, nation and community, or nation and individual. It also means appropriate rule-making bodies. Between nations it means provisions for preserving peace and measures for peaceful communications and commerce.

In prehistory, the aspects of life in which the wish for security was felt seem to have been: safety of life from attacks, assured provision of food and drink, shelter from the elements (e.g., sun, wind, storms, floods, fires, cold), and health. These are much simpler and in different order of emphasis than the corresponding exhibit for the present day, some five or six thousand years since the dawn of history, but the pressure of each of the factors named remains with us as actively as ever. Individual artisanship could do much for prehistoric men, but more was needed to launch their progression into mutually established community-loving individuals. That "more" which nature finally provided was intellectual planning for the purpose of bringing certain of the simple elements of artisanship into coordinated structures or machines. The conception and the embodiment signalizing engineering thus came into being. This required a combination of observation, rumination, and application of plans to extend operations beyond the purely empirical stage.

The result could not have occurred had not speech and writing been invented previously, and true community life could not have arisen until after engineering procedures were available. Also, as the centuries in historic time are flowing before us, it is seen that engineering is as broad in scope as the life of man and as varied as human affairs. In the stream of history, the channel is outlined by the marks of personal genius but the eddying current is impelled by the ambitions of men of all types.

The prehistoric man, and even the man in early historic times, possessed little except individual crude artisanship to aid him in sustaining the desired security, until germinal engineering arose which resulted in engineered village locations, engineered village construction, and crude metallurgy. Thence, rapidly sprang improvements in human relations and conditions of living. Note here the emphasis of the sequence: First, engineering; then community life; then ethics and morals, arising out of conditions of community life brought into being by the effect of engineering. The fine arts and then the sciences of medicine and surgery, so helpful to man in the twentieth century, followed after; as also did organized rules of law. Magic arts in life, and the fear of death, have traditionally come to us from the doctrines of magic makers or medicine men of prehistory and their practices were long sustained by the priests of early history.

At the present moment of our own lives, our nation and our people are overdoing the shout for government-supported "Security" maintained for the individual without his own aid; but nevertheless reasonable security of life and livelihood is the stuff out of which civilization has been made. Man has sought and still seeks security of life and livelihood, and also the greatest degree of convenience and comfort which may be derived from any given expenditure of energy. It is a truth as inexorable as time and silence (if we do not press the metaphor too far) that, as Sancho Panza says, "Good fare alleviates care," and we may step along a step farther with the apocryphal Paul Bunyan in saying "Meals make the man."



. . . . the doctrines of magic makers or medicine man of prehistory and their practices were long sustained by the priests of early history . . . .

(From "Across Australia," by B. Spencer, and F. J. Gilland, Macmillan Co., New York, 1912)

The phrase of the day in this twentieth century, coming to us from the nineteenth, is "seekers after truth" or "truth for truth's sake." What has it been in the long past? The most universal attitude of man has been seeking for life—that is, the maintenance of life in some security and, if attainable, in some comfort, usually recognizing that it calls for his own efforts as an individual, or as one of a group, to achieve the goal. That attitude was an attribute of prehistoric man and, without interruption, has been associated with man's development up to this moment. Seeking truth for truth's sake has little meaning (except selfishly for an individual's own satisfaction) unless the search can satisfy that attitude by leading to amelioration of inherent asperities in life's competitions. Happily it is a fact that every grain of truth which has been brought into the light of learning has contributed to such amelioration.

The definition of engineering leads to the comment that insistent tracing of facts before unreservedly drawing conclusions, as is called for in engineering, is a slow development of observation and experience, and man's average rate of correlation of experience is very slow. We therefore are not to be shocked that engineering arose so late in prehistory, and made such slow progress thereafter. Even as late as 2400 years ago, long

after the dawn of history, Sophocles noted in his "Antigone:"

> "Man the Contriver! Man the master-mind,
>
> . . . .
>
> Man the Householder, the Resourceful,
> Safe from the drench of the arrowy rain
> And the chill of the frozen sky;
> The Inventor of speech and soaring thought." [1]

After absorbing this glorious, this majestic eulogy, turn to the full part of the Chorus from which this is quoted and see how little that is beyond the powers of artisanship is therein ascribed to Man by Sophocles. Also consider how little there is in Sophocles' great works which indicates any comprehensive view of civilization. Then reflect that the date of Sophocles was some 3000 years after the date of the dawn of history on which we stand in this lecture, and less than five centuries before the opening of the Christian era. Truly, intellectual progress is deadly slow to have gone no farther by that time; but fortunately it is cumulative and for that reason we gain so much from our engineering of the twentieth century instead of continuing to strain our muscles in the way characterizing the dawn of history. It is fair to confess that, were men possessed of keener powers of intellectually relating observed things, we already would have gained much more.

Engineering is a human affair. It deals with forces and materials provided by nature, but adapts them to human service for the satisfaction of human aspirations and needs, that are felt in each particular period. This process of satisfying, stimulates human society to dream additional aspirations and picture additional needs. Life in the aggregate is a composite of many relations and always has been. To safely qualify in such a situation, engineering must live under the guiding influence of the social philosophy of the period, while controlled by the restraints which characterize exact science.

Let us now state specifically a thesis, the thread of which runs through these lectures on Engineering's Part in the Development of Civilization. Our thesis is that civilization grows along with security for the individual and for the family, clan, community, nation; that community dwelling became favored by the more intelligent people of the later era of prehistory, because the execution of engineering plans (even though rudimentary) greatly heightened the degree of security made available; that community life, thus drawn together, introduced social relations out of which grew rules, regulations, and habits of the character of ethics and morals; then during the early centuries of the historical era, engineering grew more comprehensive, giving birth to improved routes of transportation by sea and land, greater command of water supply, and other features, which enabled communities to satisfy their aspirations for joining together as nations. Out of this situation grew a still fuller realization of the need for formulated and accepted principles of ethics and codes of morals. Thus, engineering and civilization progress hand in hand, even though haltingly.

What, probably, was the direct consequence of the development of engineering up to the dawn of history, as we might have observed it had we sat in the twilight while the sun of history was rising? We may assume ourselves endowed with powers enabling us to look into the immediate centuries, both backward and forward. Here is the disclosure! Like physical prowess, this development of a useful intellectual activity, called engineering, produced leaders of the people, and around them gathered aggregations of individuals, which aggregations tended to dominate less mentally equipped fellows, even though the latter may have been of greater physical prowess. This produced horizontally stratified society which made a foundation for more exacting military development, an aristocracy of wealth, slavery, and other objectionable class conditions, which conditions sustained themselves until mental ability became more generally cultivated and sympathy more disseminated.

Thus both service and disservice were part of the early outcome of the development of engineering. The contribution of service vitally underlies all the development of civilization. The disservice, which has been much emphasized by writers and publicists in this twentieth century, has been of details. These relations will be analyzed in ensuing lectures. In the interval we must keep in mind that, in community life, formal administrative justice is a necessity for maintaining an orderly and desirable status of society. Ethical principles and justice are blood brothers, but the human-made rules for the administration of justice are not always a full realization of accepted ethical principles, although the rules arise out of the needs of the social relations in community life. The conceptions of these rules of equity and justice grow out of the relations of man with man which are imposed by the contacts in community life made possible by engineering and commerce, but rules formulated often are inadequate to the conception.

[1] Using the free and dramatic English rendering by John Jay Chapman. The Antigone of Sophocles, translated by Chapman, Houghton Mifflin Company, New York, N. Y., 1930.

Crane Hooks

(Continued from page 609)

inch of permanent deformation had occurred. Several hours elapsed between each loading and some recovery undoubtedly took place, although this could not be checked since the dial gage used in making the deformation measurements could not be left in place while making the readjustments.

Effect of loading beyond the yield point was also noted in making tests of the 10-ton crane hook. Step-loading was carried out, and, during each new loading, the hook behaved elastically up to the highest previous load and then yielded plastically, following the same curve as during yielding under the previous loading. Unloading and reloading curves were not shown in Fig. 4 because they would have confused the picture designed to show the effect of annealing on the yield point.

The important results of this investigation may be summarized as follows:

(1) Importance of periodic inspection and testing of crane hooks was clearly established. The routine should include not only annealing but also careful visual inspection for cracks, and proof-load testing.

(2) Hardness tests are of value as a rough check of carbon content. A low carbon content is likely to result in a hook that is too soft to maintain its rated load after annealing.

(3) Unless cracks are exceptionally deep, no concern need be felt concerning reduction of safe carrying capacity due to grinding them out, providing sharp changes in contour are avoided.

(4) If a hook has been severely overloaded, annealing may lower its yield point by as much as 50 per cent. Ratings should be based on the yield point in the annealed condition.

(5) Each time a hook is loaded to beyond the yield point, the highest load attained may be considered as the new yield point, provided this load is held for a sufficient length of time for most of the plastic flow to occur. The yield point can be raised more than 100 per cent by repeated overloadings.

THE W.P.A. NATIONAL RESEARCH PROJECT

By HERBERT P. NEGUS

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THE LITERATURE dealing with the problem of technological unemployment is voluminous and bitter. It is characterized by two extreme points of view. One view is that men and machines are competitive. Machines replace workers who must seek employment elsewhere and, perhaps, accept a lower wage. The other view is that men and machines are complementary. New machines need men to make them and to operate them. Goods are produced more cheaply and consumers have more money to spend on other things. The net result is said to be an increase in employment and wages. The truth, of course, is that men and machines are both competing and complementary. The final result depends upon the balance of opposing forces; society gains in the form of lower prices, but labor may either gain or lose.

While a few writers have sought to measure the social consequences of particular inventions, none have attempted a comprehensive factual study covering a large portion of our national economy.

The National Research Project[1] of the Works Progress Administration was undertaken in order to fulfill this task, and it is the purpose of this review to indicate the scope and perspective of this project and to present the findings of some of the reports which have so far been released.

SCOPE OF THE PROJECT

The National Research Program of the W.P.A. was established in October, 1935. The project on Re-employment Opportunities and Recent Changes in Industrial Techniques was organized in December to inquire, with the cooperation of numerous governmental and private agencies, into the "extent of recent changes in industrial techniques, and to evaluate the effects of these changes on the volume of employment and unemployment."

The task of the project has been to assemble and to organize the existing data which bear on the problem and to augment these data by field surveys and analyses. Reports issued to date fall into two main groups, studies of changing technology and labor productivity, and studies of the effect of industrial change on labor markets. The former studies contain descriptions of the mechanical or engineering types of industrial techniques, conditions affecting their introduction, and the rates at which they have been or are being adapted to specific uses, as well as measures of the effect of these changes on output per worker, total output, and employment opportunities. The labor market studies show the effect of industrial changes upon individual wage earners. Employment histories of over 20,000 workers have been collected showing "frequency and duration of employment periods; the number of times workers have changed occupation, employer, and industry; the relationship of age and industrial experience to occupational mobility; the sources of labor supply in new and expanding industries; and the geographic mobility of labor in relation to the migration, expansion, or decline of industries."

CHANGES IN LABOR PRODUCTIVITY

It is not possible to review here the interesting developments in industrial techniques which are described in these reports. As to the effect of technical advance on production, productivity and employment, estimates have been prepared for the economy as a whole which show that "while the nation's income produced increased 46 per cent from 1920 to 1929 (in terms of 1920 prices) total employment increased only 16 per cent during the same period. In 1935, income produced per man-year was 45 per cent higher than in 1920 and it was estimated that a return to the 1929 level of employment would, assuming the 1935 composition of the national output and the 1935 rate of productivity, have required an output of goods and services equal to 116 per cent of the 1929 level, or more than 140 per cent of 1935. When the increase in total labor supply is taken into account, using the same assumptions, a return to the 1929 level of unemployment would, by 1937, have required much greater increases in the national income produced. But the national income produced in 1937 scarcely reached the 1929 level (in terms of 1920 prices) and the lowest level of unemployment reached in the fall of 1937 was between 8 and 9 millions."

These over-all estimates are based upon detailed studies for the major types of economic activity—mining, agriculture, manufacture, and railroad transportation. The mineral industries studied include bituminous coal, anthracite, petroleum, and natural gas, phosphate rock, crushed stone, iron ore, copper, lead, zinc, silver, and gold. In general, the increased use of mechanical energy, the adoption of mechanical drilling, loading, hauling and hoisting devices, has more than offset the increased physical handicaps in mining, reductions in grades of ore and the shorter work day and work week, and has resulted in a sharp upward movement in output per worker. A report on "Technology and the Mineral Industries" concludes that: "In coal mining the forces making for labor displacement are strong enough to be a cause of some concern. In metal mining also the chances of expansion beyond the level of the 1920's seem unfavorable. In oil and gas, on the other hand, the trend points to an increase in total labor requirements. . . . . Taking the mineral industries as a group there seems little chance that the total demand for labor will rise greatly above the levels of the 1920's."

Surveys of the principal agricultural crops reveal large increases in productivity and a shrinking proportion of agricultural to total population due to the progressive application of modern technology. Mechanical changes, the introduction of power plows, tractors, and motor transport, have had the largest effect on man power. In the production of corn, the most important crop in terms of both value and acreage, there has been an average decline of 20 per cent in hours per acre since 1909. A similar decline is found in cotton and it is stated that the mechanical cotton-picker may displace two million workers for the 40-day picking season.

In the manufacturing industries it is estimated that total production increased by 115 per cent between 1900 and 1919, and another 40 per cent by 1929. The number of wage earners in-

[1]National Research Project on Re-employment Opportunities and Recent Changes in Industrial Techniques, Works Progress Administration, Washington, D. C.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

created about 80 per cent to around 9 million in 1919, and was about 2 per cent less in 1929. Comparable indexes of production, employment, and productivity have been prepared for 45 industries accounting for about half of the employment in manufacturing in 1929. Between 1919 and 1929 only two of these industries, knit underwear, chewing and smoking tobacco and snuff, accounting for one per cent of the employment coverage, experienced a decline in productivity, while five others, accounting for 15 per cent of employment coverage, showed an annual increase in productivity of less than 2 per cent. Eighteen industries, accounting for 38 per cent of employment, increased their productivity on the average, by 2 to 6 per cent, while sixteen others, representing 43 per cent of total employment coverage, showed average annual increases of 6 to 10 per cent. The beet-sugar, chemical, cigarette, and electric-lamp industries, comprising more than 2 per cent of employment covered, increased their productivity between 1919 and 1929, by an annual average rate in excess of 10 per cent. Productivity continued to increase between 1929 and 1935 for most manufacturing industries but at a somewhat lower rate. Nonetheless, the rate of increase in four industries, confectionery, glass, knit underwear, and silk and rayon goods, exceeded 10 per cent. The depression probably stimulated effort to reduce unit labor requirements by speeding up operations and introducing improvements requiring little capital outlay. However, agricultural implements, coke, clay products, nonferrous-metal products, and planing-mill products, showed a decline in productivity.

LABOR-MARKET STUDIES

Labor-market studies have been made covering the railroad workers, the cigar makers of Manchester, N. H., and the textile, metal, and radio workers of Philadelphia. Other studies are in process. The study of railroad workers is based on the personnel records of 400,000 employees of 13 Class-1 railroads. Employment experience is related to age, experience, and occupation, and to changes in railroad technology. The Manchester study is based on work histories of 600 male cigar makers who were replaced in 1931 by about 200 female machine operators taken on to make a cheaper product by automatic machinery. During the five years after the layoff, the cigar makers as a group were without work 52 per cent of the time, though able and willing to work and actively seeking employment. Nine per cent of their time was spent in self-employment in the cigar industry, 10 per cent in working for others in the industry, and 17 per cent in working outside the cigar industry. The remaining 12 per cent of the time was accounted for by those who became too old or otherwise disabled for work. The cigar maker's skill is not transferable to other industries.

The W.P.A. studies constitute a substantial contribution to our knowledge of the social savings gained from technical advance, the distribution of the savings between capital and labor, and the effect on income, production, and employment. The failure to investigate the relationship between technological change and wages is an opportunity lost. The extent to which invention is induced by increases in labor income is a problem of high importance and might well have been included in the program of the Project. The authors have not attempted to determine the number of workers who were "technologically unemployed" because of difficulties involved in establishing adequate criteria. This may be an impossible task. We know, however, that there were between 8 and 9 millions unemployed in 1937 when industrial production was almost at the 1929 level. Absorption of these workers in private industry awaits a large increase in the demand for capital goods. Prospects are limited by the fact that the peak of capital requirements for a number of our basic industries probably lies in the past.

Industry, Labor, and the Public

(*Continued from page 616*)

ers—to meet its obligations should be to make governmental regulation and restriction less necessary. It should be worth while for the several parties at interest to do those things not as a matter of "must," but as evidence of that enlightened, forward-looking intelligence which has advanced and is continuing to advance American industry and American prosperity.

We may well expect more from such leadership than other sources. Public opinion, when it responds to the hammering of industry by politicians, is in reality hammering at the quality of leadership in industry. Today management, the chief representation of industry is required to work within limits which, with each turn of the legislative wheel, are being more closely defined. To rail against this circumscription is too often evidence of management's indifference to or lack of understanding of its obligations and responsibilities.

Management may well take the first steps toward strengthening and maintaining its position by demonstrating that it "stands foursquare" to customers, workers, stockholders, and the community of which all, including management itself, are members. Then it will not be so generally vulnerable to the politician, the labor agitator, and to others who find in management's deficiencies or inconsistencies the chief source of their sustenance.

Public opinion, founded on the American sense of fair play, will be with management which realizes and lives up to its several obligations.

Courtesy of the Gorham Co.

A MASTER CRAFTSMAN IN SILVER

(An inspection trip will be made to the plant of the Gorham Co. during the A.S.M.E. Fall Meeting in Providence, R. I. See page 640.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

ISOLATED, for all practical purposes, from newspapers and technical journals, it has been pleasant to find oneself in the English Lake District with members of the Newcomen Society, and there to view what remains of age-old handicrafts and the sites of former industries.

Newcomen

To an American member the 1938 Summer Meeting of the Newcomen Society for the Study of the History of Engineering and Technology, held June 14 to 18 in the English Lake District, better known for its scenic beauty, its famous poets, writers, and artists, and John Peel (d'ye ken John Peel?) than for its industries and its engineering history, was an experience not soon to be forgotten. Yet in this region, so inaccessible in early times that parts of it resisted successfully the Norman invasion, the forty persons who took part in the meeting found much not only of antiquarian but also of present-day interest. "Kendal green" (cloth) and "Kendal brown" (snuff) are not unfamiliar terms, even to one from the western side of the Atlantic, while such a handicraft as swill making was quite as novel to the English as it was to the American students of industrial history. A "swill" is the prototype of the tote box, a shallow oval basket fabricated of oak strips, made pliable by soaking in hot water, by means of simple tools for splitting and preparing the wood, and what appears to be a very considerable amount of manual dexterity. It is used for such purposes as carrying bobbins in textile mills, fish, coal, and other commodities, and is a familiar sight in Great Britain.

With headquarters at several hotels located at Bowness-on-Windermere, and by means of motorbusses for transport over narrow winding roads that had their origin in pack-horse trails, the party of antiquarians covered an amazing amount of the Lake District, and where the condition of the roads or the bridges did not permit, trudged and scrambled afoot through coppice and up mountain slopes to recreate scenes and industries antedating the reign of Queen Elizabeth. Bright sunshine attended all the excursions.

The first visit was made to the bobbin mill of Coward, Philipson and Co., at Stott Park, where native woods, cut from the coppice, are converted into bobbins, or thread spools, in an old mill driven by a water turbine and steam engine that now supplant the original wheel. Thence, mostly by foot, the party went on to Elinghearth, where perhaps the only surviving charcoal burner of the district, Herbert Barker, pointed out what were supposed to be ancient potash hearths, explained the ancient business of charcoal burning, showed how oak was stripped of its bark for the tanning industry, and turned up the ruins of a charcoal burner's hut, of which little more than the hearth remained, and described how the crude structure was built and, from his own early experience, what hardships were endured by the charcoal burner and his usually large family during their annual six-months' sojourns in these isolated homes.

In the afternoon opportunity was afforded to inspect a charcoal iron furnace, dating from 1711, and still in operation, though not with charcoal, located at Backbarrow and shown by Arthur J. While. At Low Wood, in a stone building, formerly part of a gun-powder factory, E. Hughes, the lone swill maker, demonstrated all steps in the plying of his craft from the splitting of the oak logs and preparing the strips for soaking to the making of a complete basket, which, when duly autographed, was purchased by a member of the party and carried home to serve as a garden basket. The return journey was by way of Grange-over-Sands through Lindale-in-Cartmel, where the iron monument, designed by John Wilkinson and bearing his medallion and an inscription of his own devising, stands in great need of care and preservation. Best known, perhaps, as the maker of the boring mill that James Watt found so essential for the manufacture of steam-engine cylinders, John Wilkinson describes himself as "iron-monger;" and the inscription attests the fact that "his life was spent in action for the benefit of man; and, as he presumed humbly to hope, to the Glory of God."

At the evening assembly the distinguished historian, Rhys Jenkins, described the Society of the Mines Royal and the German colony of the Lake District which were the object of the excursion of the following day. As Mr. Jenkins showed, a Daniel Hochstetter was induced to come from Germany and in 1565 a company was formed, known as "The Governor and Society for the Mines Royal," which developed copper mining, stamping, and smelting in the Keswick District. The copper made was sent by road to Newcastle-upon-Tyne and thence by sea to London. Financially, said Mr. Jenkins in his summary, the venture was a failure, and technically the work done at Keswick had no bearing on the rise and development of copper smelting in England after 1690. The paper which followed, read by the secretary, H. W. Dickinson, in the absence of the author, John Summervell, dealt with the variety of industries and handicrafts to be found in the Kendal District, and provided an excellent background for Friday's excursions.

Thursday's motor-coach tour went via Ambleside, Wordsworth's home, to Keswick, and thence, until road conditions dictated further travel by foot, to Newlands Valley and Goldscope, where amid the treeless hills, the copper-mines, worked by the Germans in the sixteenth century, were located. Hardier members of the party proceeded up the valley with its few isolated farms and grazing sheep and scrambled to the adit of one of the abandoned mines where all that remained were a couple of clefts in the rock and a mound of mine refuse. Returning through Keswick, where lunch was had, the excursionists paused for a few minutes at a commanding site at Castlerigg to view the remains of a druidical circle, and thence by Troutbeck to Glenridding, near the southern end of lovely Ullswater, and up a steep-sided ravine to the Greenside Lead Mines, a

modern property operated by the Basinghall Mining Syndicate, here to contrast the new with the old visualized at Goldscope.

From Bowness, on Thursday, the party transferred its headquarters to Kendal, and there on Friday morning, set forth for a visit to the Burneside Paper Mills of Jas. Cropper and Company. This thoroughly up-to-date plant was a prelude to the Beck Mill (grist and oatmeal), Gilbert Bethell, proprietor, driven by a water wheel, and, hard by an old cotton mill, now converted into a cabinet shop and residence, with water power for machinery and electric lighting.

Perhaps the most striking contrast of the trip was found at Helsington, on Friday afternoon—an "engineering shop" of J. Shaplow and Company. In the center of this old shop a wooden water wheel dips into the stream and the great baulk of its axle communicates power to shafting from which the various machine tools are driven. Belted to this shafting at one end is an ancient dynamo providing current for an electric welding machine. Great interest was aroused by the finding of an old chain-driven planer. On the same flume is located the snuff-grinding mill of Gawith, Hogarth and Company, with power from a green and dripping breast wheel. Those who made close inspection of the snuff-grinding operation quickly emerged, sneezing and with streaming eyes, to admire the colorful garden of the proprietor's stone cottage.

A woodland ride by Force Fall, scene of salmon fishing and site of a ruined gun-powder works, brought the excursionists back to Kendal to the organ-building works of Wilkinson and Company where organs in all stages of manufacture and repair were viewed.

The annual dinner, with Eng. Capt. E. C. Smith, president of the Society, in the chair, was held at the County Hotel. Speeches were omitted in favor of a program of music furnished by residents of Kendal, friends of Sidney Mills, member, on whom had fallen much of the responsibility for the arrangements at Bowness and Kendal. Mr. Mills' monologs in Lancashire dialect delighted and amused members from both sides of the Atlantic.

If excuse is needed for reporting a pleasant engineering holiday with members of the Newcomen Society in England, it may be found in the hope that engineers in America will pay more attention to the possibilities for pleasure and profit in exploring the origins of their own local industries and handicrafts. Such excursions make for good fellowship, broaden the outlook, and bring us closer to the heritage of the past.

Producer-Gas-Driven Ships

ENGINEERING

GREAT interest attaches to one of the results which have followed the efforts being made in Germany to reduce dependence upon imported liquid fuel; this is the introduction of the producer-gas-driven ship, using producer-gas generators operated with coke, anthracite, or wood. The method, which is described by David Brownlie, member A.S.M.E., in an article in *Engineering* for May 27, 1938, is claimed to give more economical results than a Diesel-engine ship and to be otherwise equally satisfactory. The first ship to be operated on producer gas was the *Harpen I*, a large twin-screw tug engaged in towing coal barges on the Rhine, which was put into service on July 12, 1935. The results have been so satisfactory that already 20 or more producer-gas-driven ships are built or building in Germany.

The *Harpen I* is a flat-bottomed tug 131 ft long and 23 ft beam, with a draft of only 4.25 ft. The Humboldt-Deutz power plant consists of a producer-gas generator usually operated with small coke, situated forward of the center of the ship, with two vertical eight-cylinder, single-acting four-stroke gas engines further aft. The engines are side by side and each drive one screw. The two engines are each of 375 bhp, giving a total of 750 bhp, and run at 375 rpm. Since the engines are nonreversing a special reversing gear with disk clutches operating in oil allows them to drive the screws ahead, astern, or idle, merely by the operation of a lever on the bridge. The bridge is also provided with two other levers to vary the speed of revolution of each engine, as well as a steering wheel. It is claimed that the general maneuvering of producer-gas ships of this type is easier than with a steamship, and that "full speed ahead" can be altered to "full speed astern" without the engines altering to any appreciable degree their speed of revolution, and the same applies with transition to the "idle" position.

The normal duty of the *Harpen I* is to tow three barges each

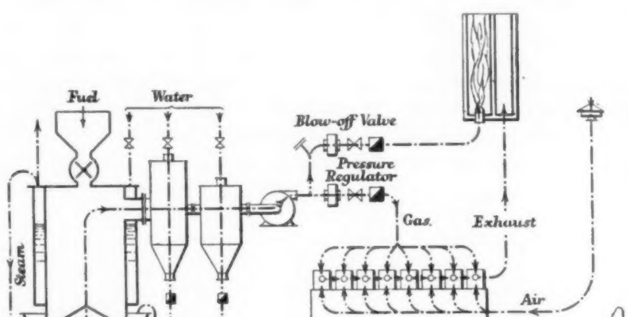


FIG. 1 DIAGRAM OF GERMAN PRODUCER-GAS-DRIVEN SHIP

carrying about 1166 tons of coal (a total of 3500 tons), at a maximum speed of about 2.7 knots against the stream, the actual journey from Duisburg to Mannheim, a distance of 54 miles, being accomplished within 18 hours.

The gas engines are of the standard Deutz GYM vertical type, which in essentials are the same as the firm's VM Diesel engines. Thus the latter can be easily changed over to run on gas, while most of the GYM engines will operate as Diesels. These vertical gas engines are made in two- to eight-cylinder units, with outputs from 30 hp to 1120 hp, operating on the single-acting, four-stroke cycle, which makes possible excellent admission, absence of gas loss, and efficient combustion control. The operating gear is arranged to be easily accessible, interchangeable cylinder liners and detachable cylinder heads are fitted, and forced-feed lubrication is supplied throughout, giving an oil consumption of 0.0055 lb per bhp-hr. Starting, as in the case of the Diesel engines, is by compressed air supplied by a small independent compressor and air-storage cylinders, while the ignition is of the high-tension type.

The Deutz producer-gas generator has a fuel feed from an upper hopper to an inner or lower fuel space beneath, and an air-cooled ash and clinker grate, both mechanically operated, together with a water-cooled cylindrical body of relatively low height. The fuel generally used is coke from the Ruhr of 0.3 to 1.2 in. graded size, and the necessary air along with the steam from the generator jacket, is passed through the grate to the fuel bed by an electrically driven blower. The operation is under pressure, and there is no danger of gas entering the engine room. In starting, an exhauster is used and the gas discharged by a separate pipe, at the end of which it is burnt, until the engines start up and provide the suction. The exhauster is then closed down. As shown in Fig. 1, the hot and

dirty gas passes from the generator outlet to a purification and cooling plant, consisting of a spray scrubber and washer, using a considerable amount of cold water for removal of dust and the small amount of tar present. The cooled and purified gas is then taken by an electrically driven exhauster, which also separates water particles and remaining traces of tar by centrifugal action, and is discharged into the gas engines. The circuit includes a gas governor and vertical burner and pipes to burn any surplus gas from the generator when the engines are stopped or idling.

Hydromatic Propeller

UNITED AIRCRAFT CORPORATION

A DESCRIPTION of a new type hydraulically controlled, quick-feathering airplane propeller, developed by Hamilton Standard Propellers, has just been received from United Aircraft Corporation which was unable to release the operating principles prior to this time because of certain American military and naval restrictions. The hydromatic propeller, as it is called, differs somewhat from the feathering propellers described in this section in December, 1937, and January, 1938.

If the pitch angles of a propeller are rapidly increased to about 87 deg at the three-quarter radius point, the rotation of the engines is stopped almost instantly and the resistance of the idle propeller is reduced to a minimum. The practice of adjusting the angles of a propeller to this position, where the chord of the blades is nearly parallel to the line of flight, is called feathering. When it is desired to feather the blades of the hydromatic propeller, an auxiliary pressure-supply system is put into operation. The pump is mounted between the engine oil tank and the constant-speed control, and sends oil under pressure through line *O*, shown in Fig. 2, to the cutout valve built into the base of the constant-speed control. The auxiliary system allows the pump to draw its oil from the engine oil tank; alternative installations have employed either a separate oil tank or used the hydraulic system of the airplane in place of engine oil and the special pump.

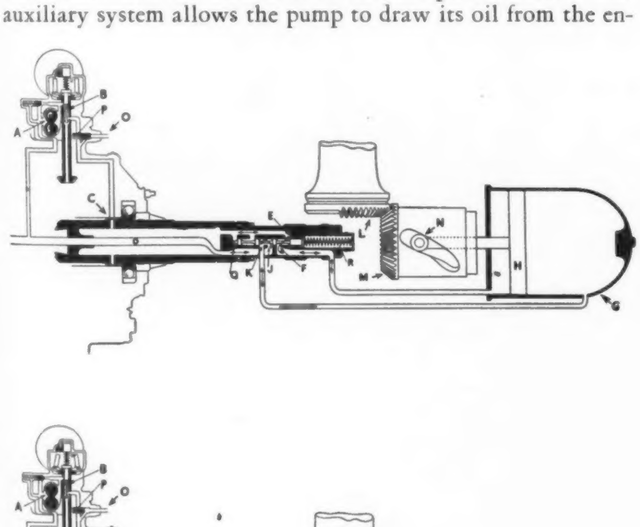


FIG. 2 SCHEMATIC DIAGRAM OF HYDROMATIC PROPELLER MECHANISM

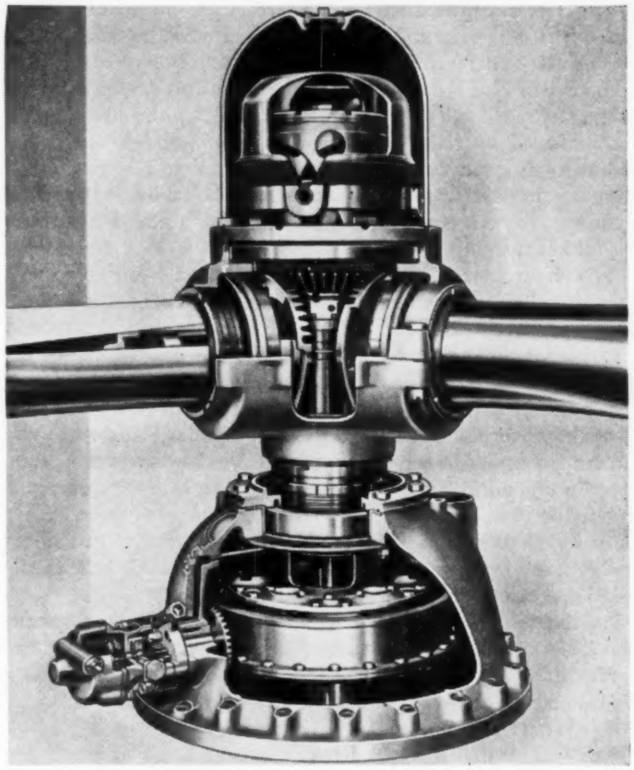


FIG. 3 CUTAWAY VIEW OF HYDROMATIC PROPELLER AND CONSTANT-SPEED GOVERNOR INSTALLED ON NOSE SECTION OF AIRPLANE ENGINE

The pump rapidly builds up pressure in line *O*, disconnecting the governor from the propeller and at the same time opening this pump line to the propeller by compressing the spring *P* in the cutoff valve. This feathering oil pressure is transmitted to the rotating propeller shaft past the oil-transfer rings *C*, see top diagram, Fig. 2, through port *E* of the distributor-valve assembly, out port *F* to the inboard side of the piston *H*. The piston moves out under this pressure, and forces the engine oil, on its outboard side in the dome *G*, through ports *K* and *J*, into the oil supply pipe *D*, and back into the engine lubricating system. As the piston moves out, the blades move to a higher pitch, and the motion is finally stopped by the rotating cam coming against an adjustable mechanical stop (not shown in the sketch) set for the fully feathered position of the particular blade design being used. With all motion stopped and the feathering pump still functioning, the feathering oil pressure builds up until it reaches 400 lb per sq in., at which point a pressure cutout switch opens the electrical circuit operating the pump by de-energizing the solenoid holding the cockpit solenoid switch in. With the blades feathered, engine rotation is stopped and consequently the blade centrifugal twisting moment and engine oil pressure have dropped to zero, and the blades remain in the feathered position. The entire feathering operation is accomplished in an average time of only nine seconds.

To unfeather the blades, the pump is again started and permitted to build up a pressure greater than 400 lb per sq in. simply by physically holding the cockpit solenoid switch closed. At approximately 500 to 600 lb per sq in. pressure, the force at

Q at the base of the distributor valve in the propeller is great enough to force the distributor valve out, compressing spring R, and the valve moves toward the position shown in the bottom view of Fig. 2, disconnecting the engine oil system from the dome. The oil from the pump starts to fill up the dome on the outboard side of the piston through ports S and K as the distributor valve moves out, and this oil starts pushing the piston in, unfeathering the blades. The oil on the inboard side of the piston is, of course, forced out through ports F and J into the engine oil system.

The hydromatic propeller during normal constant-speed operation requires two simultaneous sources of oil supply, one being oil from the constant-speed-control booster pump and the other being oil under normal pressure from the engine oil system. Referring to Fig. 2, oil from the constant-speed-control pump A is permitted to enter the hollow drive-gear shaft B of the governor and thence to the propeller shaft when the engine is turning faster than the speed for which the governor is set by the pilot in the cockpit. Governor oil is thus metered at the top port of the drive-gear shaft, and enters the rotating propeller shaft by means of the oil transfer rings C. It then follows the same path described above, for the oil during the feathering operation, to the inboard side of the piston.

At the same time, oil from the engine lubricating system under normal engine oil pressure enters the propeller mechanism through the supply pipe D in the center of the propeller shaft, and reaches the outboard side of the piston through ports J and K.

The governor oil pressure builds up until it exerts a force greater than the sum of the forces which oppose motion of the piston outward into the front of the dome. These forces are: (1) Engine oil pressure times the effective piston area; (2) the net blade twisting force consisting of the blade centrifugal twisting moment modified by the aerodynamic twisting moment; and (3) friction of the moving parts of the propeller mechanism. The net blade twisting force is transmitted from the blade gear segment L to the rotating cam M, and through the cam rollers N acting in the slots of the rotating cam, to the piston.

When the governor oil pressure builds up to a value of force on the piston just greater than the sum of the three forces, the piston starts to move out toward the front of the dome, and engine oil in front of the piston is displaced back into the engine lubricating system. This outward movement of the rotating cam increases the pitch of the blades and the engine speed is thus slowed down. As the engine slows down to the speed for which the constant-speed control is set, the pilot valve in the governor descends to the position shown in the top section diagram of the governor in Fig. 2, thus shutting off the top port of the drive-gear shaft and cutting off the supply of governor oil from the booster pump to the propeller. The oil under pressure from this pump, of course, then goes through the relief valve back to the engine, and the propeller runs on speed.

Should the engine rpm fall below the speed for which the governor is set, the pilot valve in the governor descends still further, opening the bottom of the drive gear shaft to drain. Engine oil in the dome at the outboard side of the piston is always, during normal propeller operation, under pressure from the action of the engine oil pump. This pressure acts as if a spring were placed between the outer end of the piston and the front of the dome, the spring, however, having the unusual characteristic of exerting a constant force regardless of the amount of its compression. The blade centrifugal twisting moment, aided by this "spring" force, moves the piston inward overcoming friction and the back pressure existing in pushing governor oil back through the governor to drain. As the pitch of the blades thus decreases, the engine speed picks up and the pilot valve in the governor is raised, closing off the drain through the drive-gear shaft just as the engine reaches the speed for which the governor is set.

World's Deepest Oil Well

MINING & METALLURGY

ALL RECORDS for penetration into old Mother Earth were broken on April 12, 1938, when the Continental Oil Company's oil well No. K.C.L. A-2, located near Wasco in Kern County, California, was completed after being drilled to a final depth of 15,004 ft in 284 days. According to an article by A. H. Bell in the July issue of *Mining and Metallurgy*, A.I.M.E. publication, the oil well, costing close to $300,000, or about $20 per ft to complete, is not only the deepest producer in the

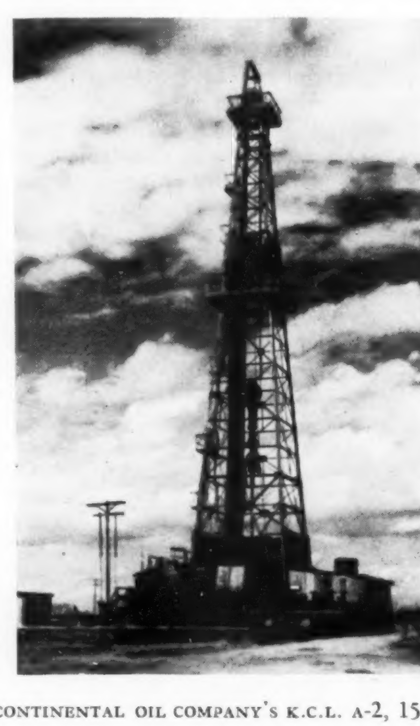


FIG. 4 CONTINENTAL OIL COMPANY'S K.C.L. A-2, 15,004 FT DEEP

world but also the straightest deep well ever drilled, the bottom of the hole being only 21 ft away from the projection of its surface location.

The only unusual features of the drilling were the chemical treatment of the mud to overcome caving shales and the fishing job which developed at 11,584 ft because of the dehydration of the heavy mud on the face of the sand encountered at that depth. Temperature readings taken at different depths indicated a temperature gradient ranging from 196 F at 6000 ft to 268 F at 15,000 ft. Preliminary subsurface pressure measurements indicated a range from 2950 lb per sq in. at 5000 ft to 5650 lb per sq in. at 13,175 ft.

Success in reaching the record depth was due to recent advances in drilling-mud technique, measurement of its characteristics, treatment with chemicals, and mechanical equipment to remove sand and other insoluble material from the mud. Helpful factors were better weight control of drill pipe, advanced design and metallurgy of drill and collars, and newly designed bits.

The drill pipe used from 11,584 ft to 15,004 ft was $3^1/_2$ in. in

diameter, range 2, internal-flush external-upset with integral tool joints, 15.5 lb per ft in weight plus extra joint weight. The gross weight of the drill pipe at the bottom was 252,000 lb of which 35,000 lb were supported by the buoyancy of the 68 lb per cu ft mud, resulting in a 217,000-lb loading at the top joint. Allowing 25 per cent additional load for impact when applying the brakes "running in" or for friction and inertia when "pulling out" gives a probable load of 270,000 lb, or a unit load for the pipe of 62,800 lb per sq in. The grade D pipe used had an A.P.I. minimum yield of 55,000 lb per sq in. However, the pipe manufacturers are now prepared to furnish special alloy drill pipe with yield points of 100,000 to 120,000 lb per sq in. To save money on a drilling operation, it would only be necessary to use this more expensive pipe for the upper portions of the string.

Another problem which cannot be as easily solved as the drill pipe is the steel-wire line used in drilling deep oil wells. The Continental well was drilled to 12,750 ft with a four-sheave traveling block having eight lines, each $1^1/_8$ in. in diameter. At 12,750 ft, the number of lines was increased to ten. But the $3^1/_2$-in. drill pipe with swivel, hook, and block had a net static weight of 234,000 lb while the wire line's ultimate strength was 92,000 lb.

As a consequence, under this heavy loading it was found necessary to cut 15- to 75- ft sections off the line after each round trip because of its stretching. Furthermore, consequent shrinkage in the diameter of the line resulted in difficulty in spooling on the hoist drum, which was of the grooved type. It is interesting to note that the line traveled approximately 40 miles on the drum for each round trip.

The largest wire line now made is $1^1/_4$ in. in diameter with ultimate strengths of 112,000–130,000 lb. But a wire line with a higher tensile strength has less ductility and can only be used economically with a 36- in., or greater, diameter drum; the largest drums in use today are only 29 in. in diameter. However, in designing a 36-in. diameter rotary drum to hoist pipe at maximum speed with 10 lines, difficulty is encountered in keeping the proper ratio of brake rim to drum diameter, about 1.9 to 1, without excessive peripheral brake-rim speed.

To save time on extremely deep wells the trend is toward 178-ft derricks with 120-ft stands of drill pipe. With ten lines up under these conditions, the drum would be required to spool 1250 ft of $1^1/_2$-in. line each time. To handle this amount of line it is necessary to lengthen the drum which in turn requires excessive drum-shaft sizes for beam strength to avoid deflection. The larger drum diameter, when full of the greater size and length of line, reduces the leverage so that increased chain loads result and engine sizes must be increased. A wider drum would also cause increased spooling trouble.

Hydraulic Couplings

THE INSTITUTION OF MECHANICAL ENGINEERS

HYDRAULIC COUPLINGS, working on the hydrokinetic principle originated by Prof. H. Föttinger, are being used extensively abroad in connection with internal-combustion engines and electric motors to drive a variety of loads of different characteristics. To acquaint American engineers with the latest development in this method of transmission of mechanical power, the Metropolitan Section, A.S.M.E., at a meeting on May 25, 1938, asked Harold Sinclair, managing director, Hydraulic Coupling and Engineering Company, Ltd., Isleworth, England, to present a ecture on the subject, based on two papers presented by him before The Institution of Mechanical Engineers, April 26, 1935, and April 22, 1938, from which the following abstract is taken.

Referring to Fig. 6, which shows a hydraulic coupling in its simplest form, the primary member or impeller is mounted on the driving shaft, and the secondary member or runner on the driven shaft. A cover is bolted to the impeller enclosing the back of the runner to retain the working fluid, a thin mineral oil. An annular core guide ring of semicircular section is

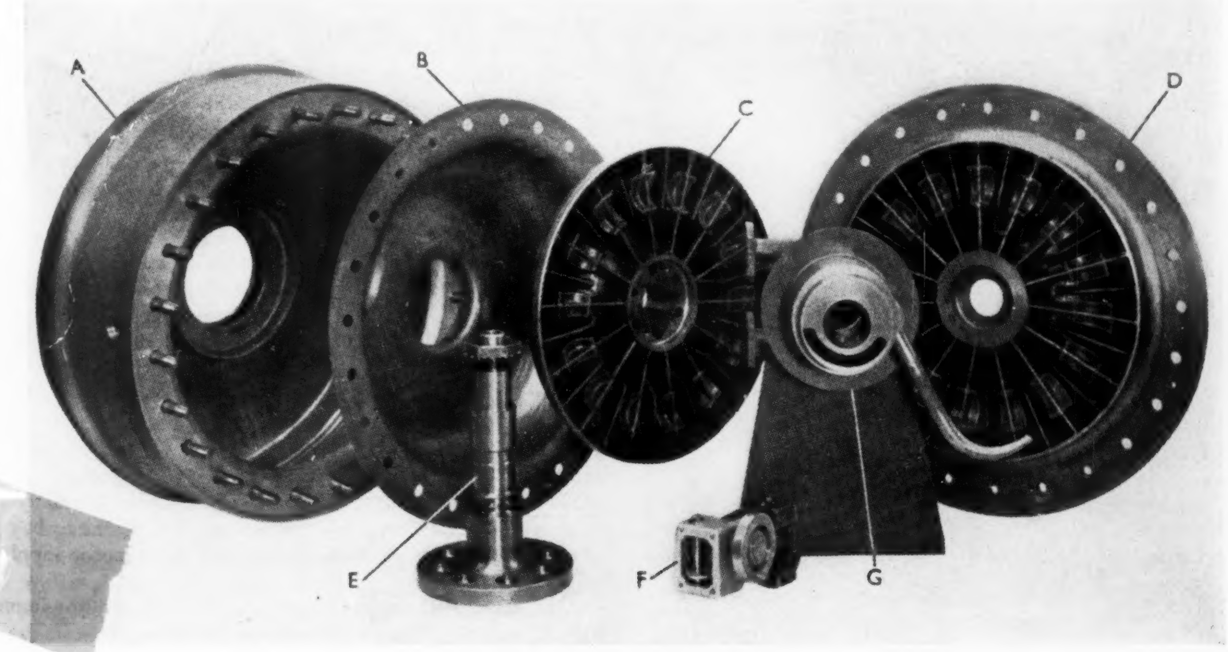


FIG. 5 SCOOP-CONTROLLED COUPLING

(*A*, reservoir casing; *B*, inner casing; *C*, runner; *D*, impeller; *E*, stub shaft; *F*, worm-geared servomotor; *G*, scoop-tube housing.)

formed with one half in the impeller and the other half in the runner. The coupling is filled by a pump through a control valve *D* and a fixed casing is provided to catch leakage oil and return it to a sump tank.

As shown in Fig. 5, the impeller and the runner are provided with 30 and 28 straight radial vanes, respectively. When the impeller is rotating, and the coupling full, the liquid in the passages between the vanes of the impeller flows radially outward under centrifugal force, as indicated by the arrows in Fig. 6. It passes across the gaps separating the impeller from the runner and flows radially inward between the vanes of the runner until it reaches the inner diameter of the working circuit, where it returns across the gap into the inlet of the impeller, and the cycle is repeated.

The drive is analogous to a centrifugal pump and reaction turbine. The liquid gathers rotational velocity in its radially outward flow between the vanes of the impeller (or pump element) and imposes a corresponding load on the driving motor. Similarly, it loses velocity in its radially inward flow between the vanes of the runner (or turbine element) and thus gives up kinetic energy which drives the output shaft. The fluid-friction loss resulting from the vortex or circulating flow is small,

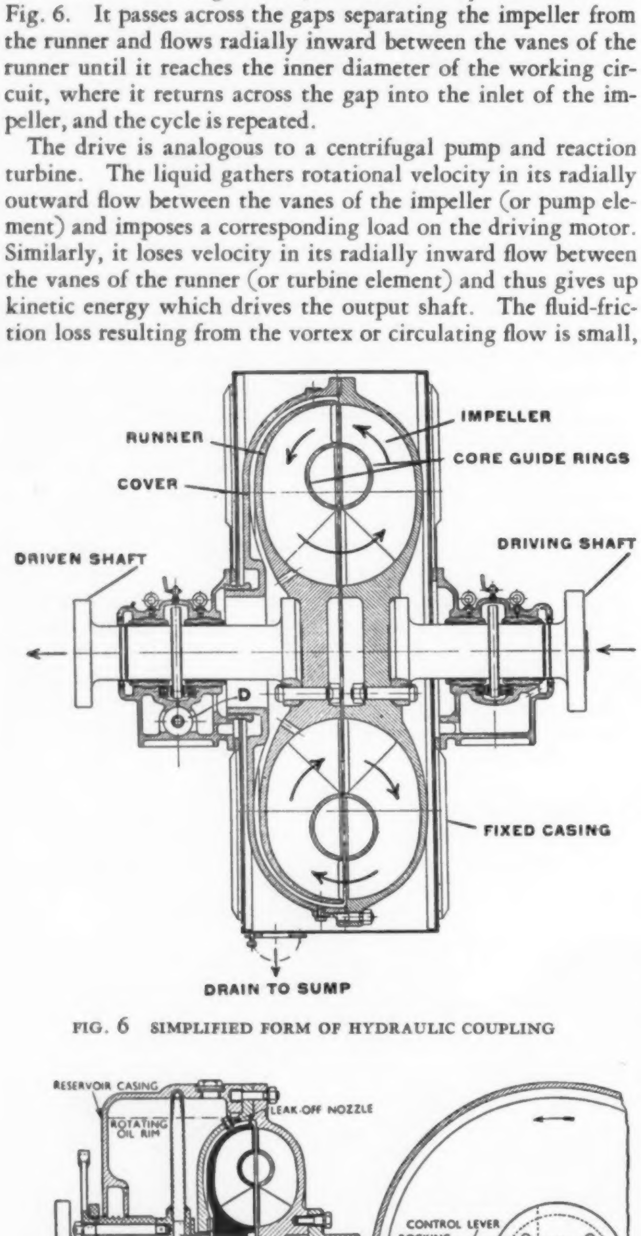


FIG. 6 SIMPLIFIED FORM OF HYDRAULIC COUPLING

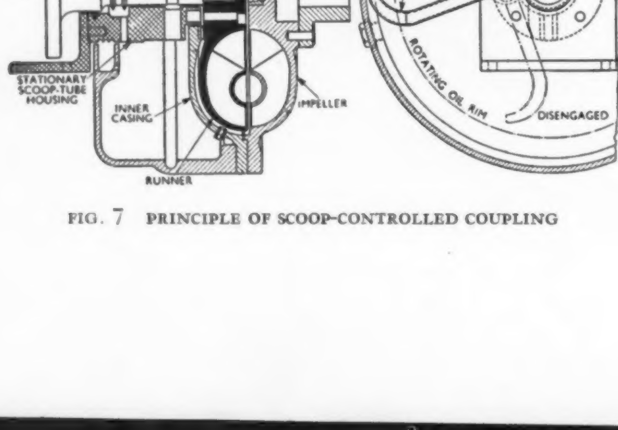


FIG. 7 PRINCIPLE OF SCOOP-CONTROLLED COUPLING

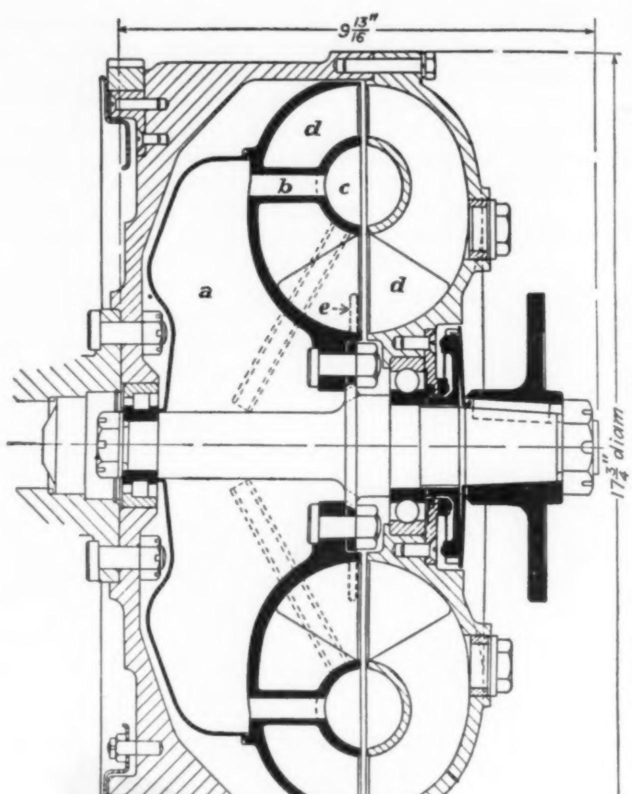


FIG. 8 TRACTION COUPLING TO TRANSMIT 130 HP AT 2400 RPM

because the body of the liquid rotates with the coupling as a whole and the relative velocity between the circulatory liquid and the curved passages of the working circle is small.

One successful type of speed-regulating self-contained coupling is the scoop-controlled coupling, having a radially movable scoop tube within a rotating chamber enlarged sufficiently to contain all of the liquid required for the operation of the coupling. This is shown in Figs. 5 and 7. Leak-off nozzles are arranged at the periphery in the usual manner. The outer casing is large enough to receive centrifugally the full contents of the working circuit, which forms a rotating annulus of the depth indicated by the dotted line in Fig. 7. When stationary, the liquid is contained in the lower half of the casing and there is no need for an external reservoir or liquid-tight glands. The scoop-tube housing is mounted on a plain bracket, the scoop itself being pivoted so that it can swing through an angle of about 70 deg and its open end moved progressively from the point where it is out of contact with the annulus of liquid and the working circuit is empty, to the fully engaged position where all of the liquid is transferred from the reservoir and the working circuit is full. The rocking of the scoop tube requires very little effort and is effected directly by a hand lever. When remote control is desired, a small worm-geared servomotor is the most convenient means; a spring-loaded clutch obviates the need for limit switches, and permits the scoop tube to be controlled directly by the hand lever if the servomotor supply is off.

A constant-filling type of hydraulic or fluid coupling in most general use is known as the traction coupling, or in its earlier form as the fluid flywheel. It is largely employed to permit easy starting and to prevent stalling of internal-combustion engines and alternating-current motors when connected to

heavy loads. The drive is taken up smoothly and automatically as the engine or motor is accelerated, and at normal speeds of revolution it is practically positive with an average efficiency of 97 to 99 per cent.

In this coupling, a reservoir chamber on the back of the runner or driven part is provided, as shown in Fig. 8. The reservoir chamber *a* is connected with the working circuit by a number of tubes *b* extending into the center of the vortex ring *c* to permit of interchange of liquid from the working circuit *d* to the reservoir, and vice versa. The objects of the reservoir chamber may be enumerated as follows: (1) To remove part of the oil from the working circuit under starting conditions, i.e., between 100 and 50 per cent slip, so as to reduce the drag torque or creeping tendency and to assist the engine in picking up the load more readily when the throttle is opened; (2) to return the oil into the working circuit automatically when a certain speed is reached, so as to reduce the slip to a very low value at normal road speeds; (3) to act as an expansion chamber so that the pressure rise in the coupling is of a negligible order, even if stalled at a high torque; (4) to separate air from oil so that the working circuit is kept centrifugally charged with air-free oil while the air collects near the center of the reservoir chamber.

The most recent improvement in the traction coupling is the introduction of the antidrag baffle, shown in dotted lines at *e* in Fig. 8. This baffle reduces the drag torque or creeping tendency when idling in gear, without impairing the slip at ordinary running speeds. A further effect is to cushion the action of the coupling if a sudden gear change should be made without synchronizing the speeds.

Under starting conditions, the centrifugal force on the driven member is low, whereas the circulatory velocity of the vortex ring is high, and in consequence the vortex ring clings to the boundary of the working circuit and is broken up by striking the antidrag baffle, thus reducing the drag torque. As soon as a certain speed is reached, the rising centrifugal force causes the vortex ring to draw away from the baffle, so that the slip falls to the normal low value, just as if the baffle were not there.

Student Selection and Industry

THE PENNSYLVANIA STATE COLLEGE INDUSTRIAL CONFERENCE

TO BE really successful, a manufacturing company must have engineers with originality and pioneering ability to keep it ahead in its field. Therefore, industry has a tremendous stake in the selection of the proper type of engineering student and his guidance throughout the educational process, according to a talk on "Industry's Stake in Student Selection and Guidance," by A. R. Stevenson, Jr., member A.S.M.E., presented at the 18th Annual Industrial Conference held by the school of engineering of The Pennsylvania State College, May 11–13, 1938. Excerpts from this talk follow:

As far as the selection of engineers goes, industry's major interest is, of course, in those young men who are especially adapted for engineering and have the ability to think independently about basic experimental laws, machines, and processes, and to have a good physical picture of them, vision, and initiative. If one wishes to pioneer and propose radical improvements and new devices, one must be sure enough of one's analysis to stand back of it and have the courage and vision to do so even in the face of tremendous criticism.

More active selection and guidance all along the line, high school as well as college, will result in much higher efficiency of the engineering educational process; consequently, industry should be much interested in selection and guidance.

The selection should be on the basis of native aptitude, and those offering the guidance should not suggest specialization too early. It is difficult to determine what type of work a person is best fitted for if he is very young; furthermore, anyone, whether working in a grocery store, on a boring mill, or in an engineering office, will be able to cooperate more effectively and efficiently with his fellow men and to regulate his own activities to better advantage if he has broad interests and knowledge. Even at the time of graduation from college, it is questionable whether a man should have specialized in too narrow a field.

What are the other qualities which help to make a good engineer? Of course, a fine character is the most important of all. Personality, cooperative ability, leadership, are of tremendous importance. So-called "cultural" courses or broadening courses are of value in enhancing the life and recreation of an engineer, aiding him socially and in turn, helping his business personality. However, in considering these semiextraneous influences, we must not lose sight of the major qualification of an engineer, technical ability to think. Without this, all the character, leadership, personality, and social polish in the world will not make a man an engineer.

In a final look at what interests industry in selection and guidance, note the wide variety of types of engineers needed in a manufacturing concern: Research scientists; development engineers, mathematically and analytically trained; and inventive, intuitive designers with initiative and courage; factory-contact engineers; application engineers; sales engineers; service engineers; executive engineers; and patent-law engineers.

It is impossible in this paper to discuss the selection or guidance of each of these types of engineers separately, but while the requirements for each of these jobs are different, there is yet much in common between them. Whether a man be a development engineer or a patent lawyer, he needs to think in terms of fundamentals; in one case the fundamentals are of physics and mechanics, in the latter the principles of law also enter. Sales engineers must have the vision to see the needs of their customers while executive engineers must foresee long-range trends and possess the initiative to make the necessary changes in policy. There are fundamentals in every kind of work and, while a man may gravitate into a type of work quite different from that which he initially set out to do, he will succeed if he has cultivated the habit of approaching new problems from a fundamental viewpoint.

Engineering and Economics

THE EIGHTH ANNUAL STEVENS ECONOMICS CONFERENCE

UNIQUE in its setting in the green hills of northern New Jersey is the annual economics conference at the Stevens Engineering Camp at Johnsonburg under the sponsorship of the Stevens Institute of Technology. There, amid trees and next to a lake, are situated 20 dormitory cabins with double-decker bunks, a mess hall, and several instruction and service buildings. It is a paradise of nature to which 150 executives, engineers, and engineering educators came this year for the period from June 24 to July 2 to listen to a series of lectures on management and economics and, at the same time, to enjoy a vacation spent in swimming, boating, golf, tennis, and rest.

Engineers, as a rule, know very little about the perplexing problem of the relationship of gold, paper money, and commodity prices. So, when James D. Mooney, member, A.S.M.E., and president of the General Motors Export Co., explained the subject at an evening session on Friday, July 1, with the aid

of a working display of glass tanks, pulleys, scales, pet cocks, etc., a contraption somewhat reminiscent of Rube Goldberg, it seemed so simple and easy to understand.

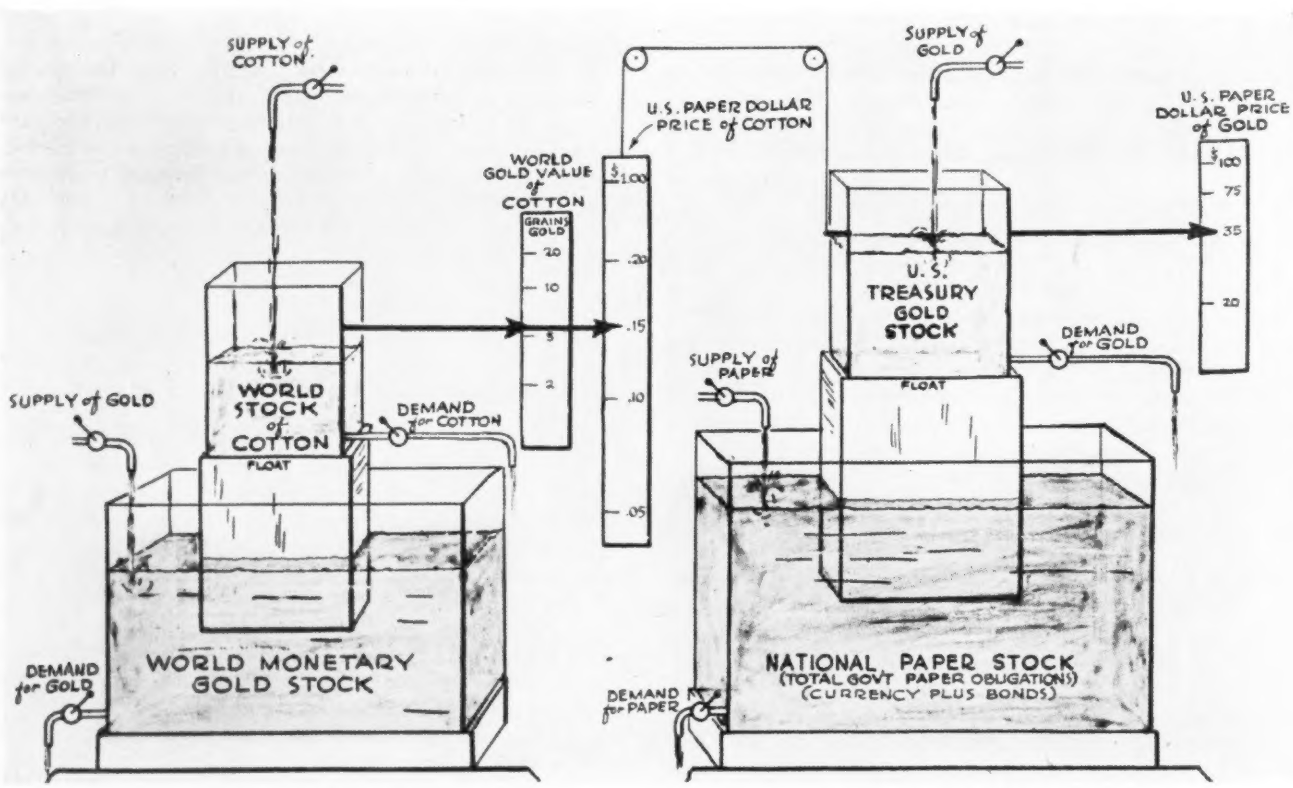
Examining the accompanying diagram one sees a small tank on the left, filled with milky water to represent cotton, floating on yellow-colored water in a large tank supposed to represent the amount of the world's gold stock. By varying the amount of water in each of the two tanks by means of the pet cocks according to scales (not shown in diagram) placed alongside of each tank, the gold value of cotton can be found on the scale in the center. On the right side of the diagram is shown the United States' gold stock, yellow water, floating on the government's debts, green water. Here, as in the other tanks, the amount of water can be varied according to scales placed alongside of each tank. In his lecture, Mr. Mooney and his associates, showed very dramatically why it was necessary for the United States to raise the paper dollar value of gold from $20.67 + to $35 per fine troy ounce in 1934 because of the increasing national debt of the government.

At the same time that the U. S. gold stock or the national debt is increased or decreased by the use of the different pet cocks, the scale in the center showing the paper dollar price of cotton is raised or lowered with the aid of a wire leading to it from the U. S. gold stock tank. After pegging the paper dollar price of gold at $20.67+ before 1934 and at $35 after that year, and using statistical figures from various reliable sources, the machine can be used to compute the price of cotton, a commodity, from 1924 to the present date. It will be seen that the resultant curve will correspond to the actual prices in existence during that period. One may even look into the future and by assuming different conditions see the results of free gold, increasing national debt, or variances in the amount of cotton.

As part of the conference, one-week courses, an hour and a half each day, were given in human problems of administration by Prof. T. North Whitehead of the Harvard Graduate School of Business Administration; motion and time study by Prof. David B. Porter of N.Y.U. and Joseph Piacitelli, members, A.S.M.E.; personnel administration by Harold B. Bergen, member, A.S.M.E.; and industrial management by Prof. George W. Barnwell of Stevens.

In a round-table discussion for teachers of management, business administration, industrial engineering, and engineering economy, the following topics were introduced and discussed by members of the A.S.M.E.: Labor turnover, by F. V. Larkin of Lehigh University; some guiding factors in applying management methods, by Joseph W. Roe of N.Y.U. and Yale; scope of management education, by Hugo Diemer of LaSalle Extension University; public-utility management, by Robert T. Livingston of Columbia University; Fred Taylor and his philosophies, by Dexter S. Kimball, past-president of the Society; and importance of standards, by John Gaillard of the American Standards Association.

Other lectures were given by A.S.M.E. members on the foreman's place in management, by Joseph L. Kopf; our national production and larger problems of management, by W. D. Ennis, of Stevens Institute of Technology; social justice, by Dean Kimball; the necessity for professional judgment in good management, by William H. Gesell, president, S.A.M.; study of the business cycle as a guide to management policy, by F. D. Newbury, economist, Westinghouse Electric and Manufacturing Co.; management's need for public understanding, by Walter D. Fuller, president, Curtis Publishing Co.; and the engineering aspects of social reorganization, by Walter Rautenstrauch of Columbia University.



COTTON—GOLD RELATIONS GOLD—PAPER DOLLAR RELATIONS

GOLD, PAPER MONEY, AND COMMODITY PRICES

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

The Bedaux System

To the Editor:

On page 514 of the June issue of Mechanical Engineering is an account of a talk made by Albert Ramond about the Bedaux system, before the Washington, D. C., Section of the A.S.M.E.

It would seem that your publication is ill-advised when it gives space amounting to almost a full page for the exposition of a system which is sold under a specialized name, but which, after all, is merely an attempt to approach the practices which have been recognized by competent engineers for many years.

Mr. Ramond makes a great point of adopting the man-minute as a "common denominator." After all, any unit of time as applied to production is a common denominator. There is nothing original or peculiar to the Bedaux system in this. There is, however, something peculiar in the assumption that, although sixty minutes constitute an hour, the so-called standards are supposed to enable the average worker to earn eighty man-minutes in an hour, or 133 per cent of standard.

As a matter of fact, the adoption of a man-minute rather than the decimal part of an hour as used by most management and industrial engineers merely complicates the calculation and adds nothing to the science of management.

Mr. Ramond also makes a point of including certain allowances in his standard for fatigue, personal delays, and delays inherent in the job. Here again he is doing nothing which has not been done for years by competent engineers. He also states that, under his system, certain avoidable delays are eliminated from the standard. This again is nothing new, except that he does not cover the point that, unless such of these avoidable delays as are due to management failure are eliminated by management, the resulting standard either is unfair to the worker or results in an accumulation of alibis. As an index to productivity, the Bedaux system is in no way superior to the straightforward standard hour basis. In fact, it would seem that the statement that a worker made 127 per cent of standard means more to the average man and is more easily translated into earnings than that he made 76 man-minutes.

The real point I am making is this: "Why should the official publication of the A.S.M.E. give space to a private exponent of a private system with the implication that it contains virtues not obtainable from competent management engineers?" It seems to me that you owe it to the great group of engineers who are doing a thoroughly competent job to point out the facts which I have enumerated above in order to offset the publicity which you have given to a single organization.

A. A. Hadden.[1]

[The talk to which Mr. Hadden refers was published as part of a news account of a meeting held by the Washington, D. C., Section of the A.S.M.E. at which Mr. Ramond was the guest speaker. Because of the interest shown by the audience in the paper, an abstract of the talk was included for the benefit of A.S.M.E. members in other parts of the country.—Editor.]

Interested in Exchange of Views in Field of Special Machine Design

To the Editor:

As members of the A.S.M.E., I am quite certain that we all thoroughly enjoy the broad field of interest covered by the Society in its publications. Many, like myself, take a greater interest in the more specialized phase of machine design because of its closer relationship to our work.

Among A.S.M.E. members interested in machine design, are, no doubt, many like myself whose machine-design activities are devoted definitely toward the development of special equipment as labor-saving aids to production.

In the sectional as well as the national meetings, I have not had the pleasure of meeting people in this definite line of work and it is my opinion, therefore, that something might be done to establish a better acquaintance between members in this particular field of endeavor.

I am, therefore, interested in knowing if this letter will bring replies from people over the country, engaged as I am in the more specific problems of special machine design.

W. C. Weber.[2]

Technique of Burning Fuel Oil and Natural Gas

To the Editor:

Mr. Philo in his paper[3] has brought out a number of interesting and important points relative to the combustion of fuel oil and natural gas. In view of the trend toward higher steam temperatures, Fig. 8 of the paper indicating relative steam temperatures with gas and oil fuels at Long Beach should be of considerable interest to those who have to do with superheater design or operation. Combined burners of the type used at this plant, but of higher capacity, are available for gas, oil, and pulverized fuel also, for capacities which exceed 100,000,000 Btu per hr each. The atomization for liquid fuel is either mechanical or steam.

Such burners with a given draft loss operate at equivalent rates of heat liberation per square inch of throat area and with a combustion efficiency equal to that obtained with the smaller burners. No corresponding increase in furnace dimensions is required merely to accommodate a higher rate of fuel per burner. It has been suggested in some quarters that larger burners might be subject to higher maintenance, but we have not found this to be the case.

One advantage of high-capacity burners, especially for liquid fuel, is the larger size of the openings through the atomizer tip and the consequent ability of such atomizers to remain in service for materially longer periods without

[1] Senior Partner, Ortman, McClure, Hadden & Co., Chicago, Ill. Mem. A.S.M.E.

[2] Chief Engineer, in charge of mechanical-development department, Corning Glass Works, Corning N. Y. Mem. A.S.M.E.

[3] "Technique of Burning Fuel Oil and Natural Gas," by F. G. Philo, Mechanical Engineering, April, 1938, pp. 315–320.

cleaning. In one plant using high-capacity wide-range mechanical atomizers, these have been left in operation for a week or more without requiring cleaning, which is in marked contrast to the frequency of cleaning required for smaller atomizers of this type.

With the lesser number of larger burners required per furnace, wide capacity range is of utmost importance especially in installations using automatic combustion control. These larger burners are in respect to capacity range on a par with the smaller ones and because of improvements, particularly in the atomizer design, which apply to both small- and large-capacity atomizers, the effective capacity range has been increased materially. In connection with the mechanical burner of the wide-range type, the constant-differential method of operation combined with the wide range system as mentioned by Mr. Philo has been an important factor in regard to capacity range.

In reference to capacity range with gas fuel, Mr. Philo refers to the gas pressure at maximum capacity as being 3 lb per sq in. and reports that:

> When burning gas fuel, all burners are fired for all loads, it being possible to reduce the gas input safely to a point where the boilers are generating practically no steam. Some minor changes in the combustion-control system make possible an increase in the fuel and air supply on the six boilers from minimum to maximum in 45 sec.

Mr. Philo has referred to the cracking of cast gas chambers at Long Beach and points out that this difficulty was overcome by a sectional design. Our experience has shown that the tubular wishbone type of gas chamber is a further improvement over the sectional cast design. With the tubular chamber or ring completely cooled both in respect to its inner and outer peripheries by the combustion air, when burning oil as well as when burning gas, no special metal is required for the ring. However, when gas rings are not fully exposed to air cooling or are embedded in refractory, special heat-resisting metal must be used and it has been found in some cases that even such special metals are not fully effective in respect to prolonging the life of these parts materially. Avoiding a multiplicity of gas joints in the burner wind box is important. This means that a burner with a single connection to the gas header and a single connection to the gas-burner chamber is preferable to one with a multiplicity of connections and joints.

Some recent boiler designs use furnaces in which a large portion of the furnace envelope is "black surface," and the question frequently arises as to the operation at reduced capacities with oil fuel because of the small quantity of refractory in the furnace. In this connection, it should not be forgotten that, about 1926, there were installed a considerable number of large oil-fired almost completely black boiler furnaces, with fin tube walls and floor water screens and that, for years, those plants have been operating at reduced capacity with fuel oil involving extremely low heat liberation in the furnace with excellent results. In such furnaces, of course, it is much more difficult to obtain good results at reduced capacities than at maximum capacities.

Water cooling of the walls through which the burners fire has made it necessary to bend waterwall tubes around burner openings. This has received considerable prominence in recent years but is not new, our first installation of this kind having been made in 1928. In that case, the burner throats were integral with the furnace waterwall and the wind box, together with the burners, was mounted on springs. In other installations, waterwall tubes have been bent in such a manner as to permit relative motion between the tubes and the burner tile, and, in such cases, spring mounting for the wind box and burners is not required. Bends in the waterwall tubes are arranged so as to provide for the maintenance of fixed minimum clearances during any relative motion of the waterwall and the burner throats so as to avoid any impingement of the fuel on the tubes.

Vertical firing, both upward and downward, has been used for a number of years with certain types of refinery oil heater, and there has been an occasional small boiler installation using upward firing. However, the fact that this type of firing has been used most successfully in the burning of fuel oil in a number of modern boiler furnaces has received little, if any, comment in the published literature on the burning of liquid fuels. Upward firing has definite advantages where it is desired to convert a stoker-fired plant to oil firing and to leave the stoker in place. In such cases, the burners fire upward through a new floor in that part of the furnace bottom formerly used for ash discharge, the stoker is bricked over to protect it from the furnace heat and is cooled by the combustion air on its way to the wind box housing the liquid-fuel burners.

In one installation using upward firing, three boilers are each fired by five mechanical atomizers. With all burners in service, they have been operated up to a capacity of approximately 5500 lb of oil or 100,000,000 Btu per hr each, the heat release per cubic foot of furnace volume under those conditions being approximately 60,000 Btu per hr. In another plant, four burners under each of eight boilers fire vertically upward at a capacity of 2700 lb of oil per burner per hour, the distance from the burner floor to the center of the tube bank of the straight-tube boiler being 11 ft. Under these conditions, the heat release per cubic foot of furnace volume per hour is 47,000 Btu. No flame is in the tube bank, with excess air at the boiler outlet running between 15 and 20 per cent. Other interesting installations employing upward firing to advantage include that of the mercury-vapor boiler at the Hartford Electric Light Co.

Sometimes, however, when converting an installation from stoker to oil firing when it is desired to leave the stokers in place, horizontal firing is employed. One installation involving this type of conversion uses high-capacity mechanical atomizers firing horizontally over a bricked-over stoker. The furnace is approximately 17 ft deep and the burners fire 5000 lb of acid sludge per hour each; the heat release is approximately 30,000 Btu per hr per cu ft of furnace volume.

While upward firing is particularly applicable to stoker conversions which, of course, do not occur frequently in this part of the country, nevertheless it has distinct advantages which are not generally recognized, especially when the burners can operate over a wide range of capacity without attention, thus making remote and automatic control of fuel and air possible.

R. C. VROOM.[4]

TO THE EDITOR:

Mr. Philo is an authority on the burning of natural gas and oil, and the paper constitutes a valuable contribution to the literature of that subject. His analysis of gas and oil burning, presented a few years ago, is remembered as one of the first careful and comprehensive studies published on the utilization of these fuels in utility steam plants.

Near the end of the paper, he states that control equipment is "set to burn both gas and oil fuel with 15 per cent excess air which is a good operating value." It is believed that, under some conditions, 10 per cent excess air may be approached, in burning natural gas, rather than the 15 per cent specified as

[4] Chief Engineer, Peabody Engineering Corporation, New York, N. Y. Mem. A.S.M.E.

practice at Long Beach. Approximate tests carried on a year or two ago at a southern gas-burning station showed that excess air even below 10 per cent could be carried, with no indication of carbon monoxide or unburned hydrocarbons. Experience also indicates that use of heated air for combustion assists in reducing excess air. It is recognized, however, that no complete and satisfactory tests have as yet been worked out for determining losses resulting from presence of carbon monoxide and unburned hydrocarbons; it is doubtless unwise to cut too close on use of air, particularly if boilers are equipped with economizers or air heaters, which reduce losses resulting from excess air.

One of the charts, Fig. 7, plots "Efficiency, Per Cent" against "Output, Millions of Btu per Hour," and "Rating, Per Cent." Figs. 6, 8, and 9 are, however, plotted to abscissas "Rating, Per Cent" only. It is the writer's feeling that, especially in an important technical paper of this kind, the old practice of utilizing percentage rating should be definitely abandoned, as indeed has been done in the A.S.M.E. Power Test Code for Stationary Steam-Generating Units. If a unit of heat-transfer rate is desired, heat units per square foot per hour can be used, or even, as an approximation, pounds of steam per square foot per hour. However, in most of the larger modern boilers, rate of heat transfer or evaporation per unit of boiler heating surface proper is of little significance in studying over-all performance of steam-generating units.

Louis Elliott.[5]

To the Editor:

Much of the equipment used as a basis for this article was installed in 1928 and 1930. It represented the best practice at that time and, to a large extent, the eight or ten years' operating experience secured since its initial operation have been used in arriving at the conclusions presented.

It is interesting to note that the tubular wishbone type of gas chamber mentioned by Mr. Vroom was considered as a solution of burner distortion trouble encountered during the initial operation of the station, but because of structural conditions was abandoned in favor of a type matching more closely the original design. Such burners with a single connection and ample area to insure proper distribution of the gas fuel would undoubtedly be a satisfactory solution of this problem.

In presenting tests of this equipment before the June, 1930, meeting of the A.S.M.E. the author stated an opinion that heat-liberation rates as high as 60,000 Btu per cu ft per hr might be satisfactorily maintained in furnaces of this type. Mr. Vroom presents data from present-day practice confirming this prediction. As he states, the application of both gas and oil fuels is flexible and can rather easily be modified to accommodate existing equipment. The principal difficulty in such installations is adequate protection of the original combustion equipment against heat while it is inoperative.

Mr. Elliott is correct in stating that natural gas can be burned with less than 10 per cent excess air. It has been found possible to operate on gas fuel with as low as 5 per cent excess air without encountering combustibles in the flue gases or secondary combustion in the boiler. In the case of the equipment described with exit flue gases from the air preheater below 300 F, the decrease in boiler efficiency between 5 per cent excess air and 15 per cent excess air amounts to only 0.3 per cent. This is offset by a rise of 11 F in steam temperature due to the excess air, and the net result is a slight decrease in over-all station economy. Since combustible losses increase rapidly with a deficient air supply it was considered good practice to allow a margin of 10 per cent which would accommodate a simultaneous increase of 5 per cent in fuel and a decrease of 5 per cent in air without entering the danger zone of incomplete combustion.

The use of "Boiler Rating" as abscissas for some of the curves was perhaps unfortunate, as Mr. Elliott states. At the time this equipment was installed performance was commonly stated versus boiler rating and the test data were plotted accordingly. Conversion to the now more conventional units is easily made since Btu per sq ft per hr equals rating times 3348.

F. G. Philo.[6]

Graphite Films

To the Editor:

The writer has read with much interest in the June issue the abstract of Dr. Stuart's article on the "Industrial Applications of the Physical Properties of Graphite" which was originally published in *Engineering*, for March 11.

Upon reading this, however, one is likely to be led to believe that colloidal graphite can be made to adhere to surfaces only when mixed with gelatin and potassium bichromate. This, of course, is not the case. An aqueous dispersion of colloidal graphite in the form of "Aquadag" is capable of forming upon solids by brushing, dipping or spraying, tenacious, homogeneous graphite films which are highly unctuous, possess a low coefficient of expansion, are good conductors of electricity, are resistant to electrical bombardment, are photoelectrically poor as well as radio inactive, and are highly resistant to oxidation. Furthermore, such surfaces have a matte-like finish and possess a high black-body factor, thus making them valuable in the promotion and absorption of thermal radiation.

Graphite surfaces formed in this manner are enjoying numerous diversified uses in the arts and industries.

Raymond Szymanowitz.[7]

Recent Developments in Hot Pressing of Plywood

To the Editor:

In my conception, it should be the aim of scientifically trained engineers, who are engaged in the production of veneers and plywood and also in the construction of the necessary machinery, to raise the standard of plywood panels to the level of those materials with which this product has to compete. Plywood numerically defined as to its physical and chemical properties, can be used by the technical designer and draftsman in the same efficient way as other materials, such as plates of iron, steel, aluminum, or other metals.

Nature does not produce the raw material according to specifications or so that it can be remelted and recomposed as can metals, but this is no reason why we should follow the old methods since the present state of the art shows that, by multilaminating the raw material and suitably recombining the laminated-wood elements in gluing them properly, a product can be obtained, the properties of which are even enough to use it in the same technical manner as other materials. Results that were achieved in Europe with aircraft plywood are ample proof of the possibilities of this product.

To obtain a panel of even properties in the technical meaning of the word it is necessary in the first place to have

[5] Consulting Mechanical Engineer, Ebasco Services, Inc., New York, N. Y. Mem. A.S.M.E.

[6] Superintendent of Steam Generation, Southern California Edison Company, Long Beach, Calif. Mem. A.S.M.E.

[7] Technical Director, Acheson Industries, Inc., New York, N. Y.

evenly cut veneers and cores. Cost of labor is the same, whether it is paid for the precise cutting of veneer on a suitable slicer or lathe, or the cutting of veneer as unevenly as intimated by Mr. Merritt.[8] It is an established fact that the modern slicers and lathes which, incidentally, do not involve additional expense, cut the veneers with such precision that no necessity arises to provide special features in the construction of spreaders and hydraulic presses to take care of irregularities of the veneer thickness. In my opinion, it would not be in the interest of the plywood industry to develop machinery that encourages the continuance of cutting veneers improperly, since the consequences in the quality of the finished product are imperiling the possibilities of its efficient use. Machines are developed for cutting properly prepared logs with such precision that, from this angle, the finished panel can compete with rolled-metal sheets, and the price of this product need not be higher than at present. If the industry would demand machinery, such as has been obtainable in Europe for many years, with a guarantee for precise cutting within narrow limits, the constructor would be able to supply it in this country. An article dealing with modern veneer cutting in Europe will be published shortly. The same applies to presses; flexible heating plates are only desirable for a certain kind of mold and bentwork, whereas rigid steel heating plates, demanding a certain precision in the thickness of the veneer, are the construction for the quality product that should be aimed at for the benefit of the plywood industry.

Several kinds of glue have been used for "low-temperature hot pressing" in Europe; in fact, they were predominant for thirty years until resin glues appeared on the market and overtook them. The belief that coniferous wood deteriorates when subjected to temperatures such as are required and recommended for certain resinous glues, approximately 320 F, has been proved to be unfounded. This is confirmed by the results of research made by Professor Gerngross of the Technical University in Berlin, Charlottenburg, published in 1930.[9] It seems strange to see this point stressed in favor of gluing under lower temperatures when it can be observed that most of the coniferous veneers used on the West Coast are subjected to such high temperatures in the drying machines.

Except for the name, "mastic glues" are not new and never have been a practical proposition owing to the difficulty in spreading them thin enough to obtain a competitive, price for the glue line. Almost all hot-setting liquid glues can be applied in a "mastic" consistency. Such experiments have cost chemical and plywood manufacturers thousands of dollars and have always led back to glue film or liquid glues of higher viscosity.

L. M. C. WEGNER.[10]

[8] "Recent Developments in Hot Pressing of Plywood," by E. H. Merritt, MECHANICAL ENGINEERING, February, 1938, pp. 133–134 and 140.

[9] "Furnier und Sperrholz," by L. M. C. Wegner, M. Krayan, Berlin, 1930, vol. 2, p. 223.

[10] Consulting Engineer, Chicago, Ill. Mem. A.S.M.E. Deceased May 19, 1938.

Water-Cooled Underfeed Stokers

TO THE EDITOR:

We have an eight-retort water-cooled underfeed stoker in operation at the Austin municipal power plant. This unit is installed under an 80,000-lb per hr, 425-lb per sq in. gage pressure, 750 F total temperature, V-type bent-tube boiler and was put in service in March, 1937. After approximately ten days' operation, a pinhole leak developed at the lower end of the stoker in a retort tube of the stoker cooling system. Comprehensive study indicated that inadequate circulation in the retort tubes caused the failure. The circulation in the retort section of the stoker cooling was remedied by increasing the number of risers and bringing them into the furnace just above the inclined side waterwalls. After the change was made, a thorough study of tube temperatures and frequent inspections were made, showing that the circulation is now adequate. Since this change was made, we have burned over 3000 tons of various grades of coal without further trouble and to date no maintenance expense has been incurred in the entire unit.

A low grade of raw screenings from northern Illinois was successfully burned in our water-cooled stoker. No operating problems were encountered with this coal as far as efficient burning was concerned. The ash formed was, however, dense and could not be removed by our ash-pumping system. This can be corrected, however, by putting in an ash grinder. We are well pleased with the completeness and ease with which the water-cooled stoker handled what would have been an impossible fuel on our older air-cooled units.

Earlier in the history of this type of water-cooled stoker, some question was raised as to the tuyère cooling tubes from an abrasive standpoint. In our case, after burning over 3000 tons of coal, the mill scale still remains on the tuyère tubes.

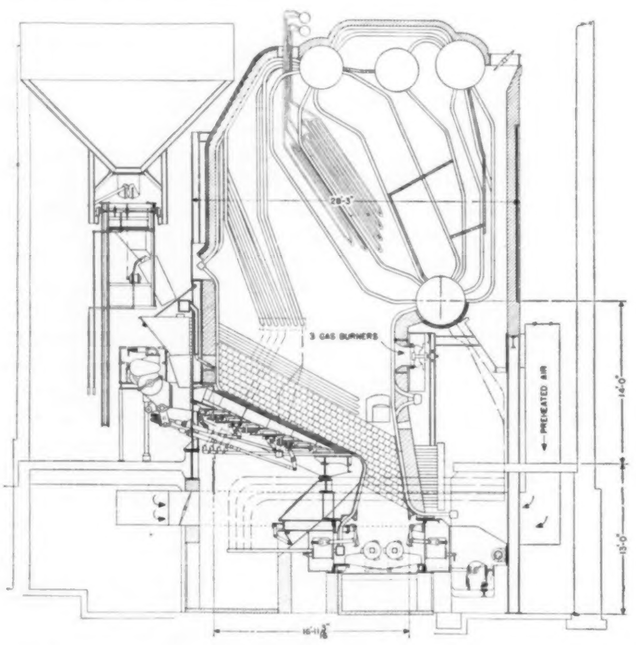


FIG. 1 AN EIGHT-RETORT WATER-COOLED UNDERFEED STOKER INSTALLED IN THE MUNICIPAL POWER PLANT AT AUSTIN, MINN.

We are equipped to burn natural gas and fuel oil through the back bridge wall over the water-cooled stoker as illustrated in Fig. 6 of Mr. Bennett's paper.[11] As compared with other available fuels,

[11] "Water-Cooled Underfeed Stokers," by J. S. Bennett, MECHANICAL ENGINEERING, January, 1938, pp. 33–36.

we have a favorable natural-gas rate. In our original studies, we recognized that, to burn a high percentage of natural gas in a combination gas-and-coal-fired unit, two types of unit were available, the pulverizer and the water-cooled stoker. To compete with gas, we also wanted to be able to burn low-grade coals. After a thorough and rather extensive economic study covering expected life of the equipment including auxiliary-power costs, maintenance expense, stack nuisance, and heat balance involving high preheated air, our selection was the water-cooled stoker.

With our experience to date, if a second unit were to be installed, we would eliminate the oil-burning equipment. We have found that we can change from gas back to coal in 5 to 10 minutes under normal load conditions which is as quick as changing to oil unless advance warning be given so that the emergency oil pumps could be started previous to the time of change-over. Although a poor grade of raw 1-in. southern Illinois screenings was used for test, the efficiency over a 28-hr period, when supplying the entire plant demand with all load changes, was 85.13 per cent as against an expected efficiency of 84.98 per cent.

A second test was run using natural gas as a fuel. The coal fuel bed was completely burned out before starting the test. During the test, only sufficient coal was supplied to prevent a fire in the stoker hopper. The stoker was given one revolution per hour and the coal so fed was 115 lb per hr or a total of 690 lb for the 6-hr gas test. The efficiency when burning gas over the stoker shown in Fig. 1, page 638, was 83.24 per cent as against an expected efficiency of 82.3 per cent. Both tests were run in accordance with the 1936 A.S.M.E. Power Test Codes.

C. L. ELLIOTT.[12]

[12] General Superintendent, Municipal Power Plant, Austin, Minn.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of June 10, 1938, which were subsequently approved by the Council.

CASE No. 834

In the inquiry, where the chemical composition of the material is given, the manganese content has been changed to read:

"Manganese, per cent.......0.40–2.50"

CASE No. 860

(Special Ruling)

Inquiry: For hot-water storage-tank service, may design calculations for nickel-clad steel be based upon full thickness of the composite plate? Evidence is submitted that nickel-clad steel in full-thickness tests shows a strength at least equal to that of an equal thickness of the base metal, and butt welds can be made under proper restrictions to meet all of the requirements of Par. U-68.

Reply: For hot-water storage-tank design, the full thickness of the composite plate may be used in the calculations only if constructed under Pars. U-69 or U-70 and provided the following additional requirements are met:

(1) The welding process qualification and the welding operator qualification tests include reverse-bend tests;

(2) Production test plates similar to those required for Par. U-68 construction be made for each vessel or each 200 ft of weld in duplicate vessels and that these test plates meet the respective elongation requirements;

(3) The edges of the plates at the longitudinal joints shall not have an offset from each other in excess of the thickness of the cladding;

(4) The depth of the nickel bead be kept to a minimum;

(5) No fillet weld be allowed in longitudinal or girth joints, except for dished heads convex to pressure (See Fig. U-14*c*).

CASE No. 861

(Special Ruling)

Inquiry: Case No. 834 covers Par. U-68 unfired pressure vessels of stabilized chrome-nickel steel conforming to A.S.T.M. Specifications A 167-35T, grade 4. Will it be permissible to apply the code symbol stamp to unfired pressure vessels fabricated to Par. U-69 omitting the heat-treatment and special tests required in the reply to Case No. 834?

Reply: It is the opinion of the Committee that stabilized austenitic chrome-nickel steel conforming to A.S.T.M. Specifications A 167-35T, grade 4, may be used for vessels constructed to Par. U-69 with the following limitations:

(1) The chemical composition and physical properties are modified as follows from A.S.T.M. Specifications A 167-35T, grade 4:

Carbon, max, per cent	0.07
Manganese, per cent	0.40–2.50
Chromium, min, per cent	17
Nickel, min, per cent	9.5
Columbium,[1] min, = 10 times carbon content; 1 per cent max	
Titanium,[1] min, = 6 times carbon content; 0.60 per cent max	
Tensile strength, lb per sq in., min	75,000
Yield point, lb per sq in., min	35,000
Elongation in 2 in., min, per cent	30

(2) Maximum temperature of 600 F; maximum pressure of 400 lb per sq in.; maximum thickness $^1/_2$ in.; allowable stress 15,000 lb per sq in., with a joint efficiency of 80 per cent.

[1] Either columbium or titanium shall be used.

Correction to Fig. P-17 in 1937 A.S.M.E. Code for Power Boilers

THE ordinate of the curve in this figure is now given as "allowable loading, lb per sq in.;" it should read "allowable loading, lb per in." The abscissa is now given as $\frac{\text{"outside diameter"}}{\text{(wall thickness)}}$; it should read $\frac{\text{"outside diameter"}}{\text{(wall thickness)}^2}$.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Providence Industries on Parade, A.S.M.E. Fall Meeting, Oct. 5–7

Inspection of Plants of Brown & Sharpe Co., G.E. Base Works, Gorham Manufacturing Co., U. S. Rubber, Narragansett Brewing Co., and Esmond Mills

THE COMMITTEE on Plant Trips for the A.S.M.E. Fall Meeting in Providence, R. I., Oct. 5–7, has been doing yeoman's service in arranging a program of inspection tours that engineers will enjoy.

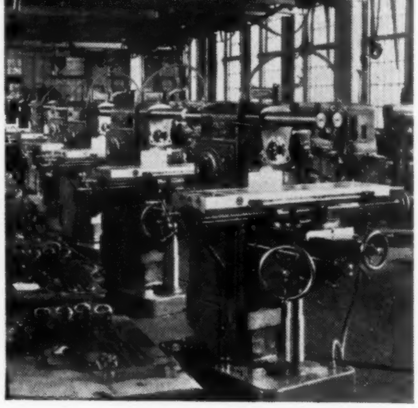
The Brown and Sharpe Plant

The plant of the Brown & Sharpe Manufacturing Co. in Providence, heads the list. It is one of the oldest industrial plants in Providence having been established in 1833. From a very modest beginning, connected with the watch and clock business, the products of this concern have been increased in number so that today they are found in practically every civilized country of the globe where metal is worked.

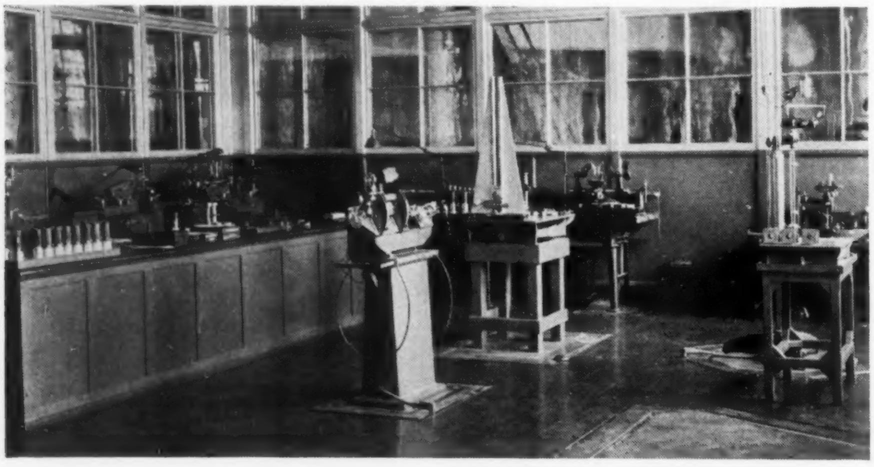
Early in the business, precision measuring tools were manufactured. Then gear-cutting and screw machines were invented and developed as well as many associated items of machine equipment. In the past few years noticeable advances have been made, especially in machine tools. Electrical controls have been introduced to give opportunity for greater production and more closely controlled accuracy and improvements made in the electrical drives of the machine tools to give greater operating efficiency and flexibility. Many changes have also taken place in machines to permit higher speeds and feeds for the machining of many new materials. Recently, also, new developments in precision tools have taken place, including, especially, the introduction of micrometers and other tools of stainless steel.

Of special interest will be the constant-temperature room in the Brown & Sharpe plant used to test gages, vernier tools, inside micrometers and other precision measuring instruments so that the testing is done at a uniform temperature reducing the liability of error due to temperature fluctuations. This room, one corner of which is shown in the accompanying illustration, is kept at a temperature of 68 F, the temperature most generally recognized as standard for gaging and measuring purposes and the humidity carefully controlled.

Especially designed testing machines are set in special vibration-proof foundations which insulate them from the building and against shock. These machines are checked at intervals with master standards which are periodically calibrated by the National Bureau of Standards.



MILLING-MACHINE ASSEMBLING AT BROWN & SHARPE PLANT



CONSTANT-TEMPERATURE ROOM FOR PRECISION MEASURING AND INSPECTING, BROWN & SHARPE MANUFACTURING CO.

(Note special vibration-proof foundations.)

The G.E. Providence Base Works

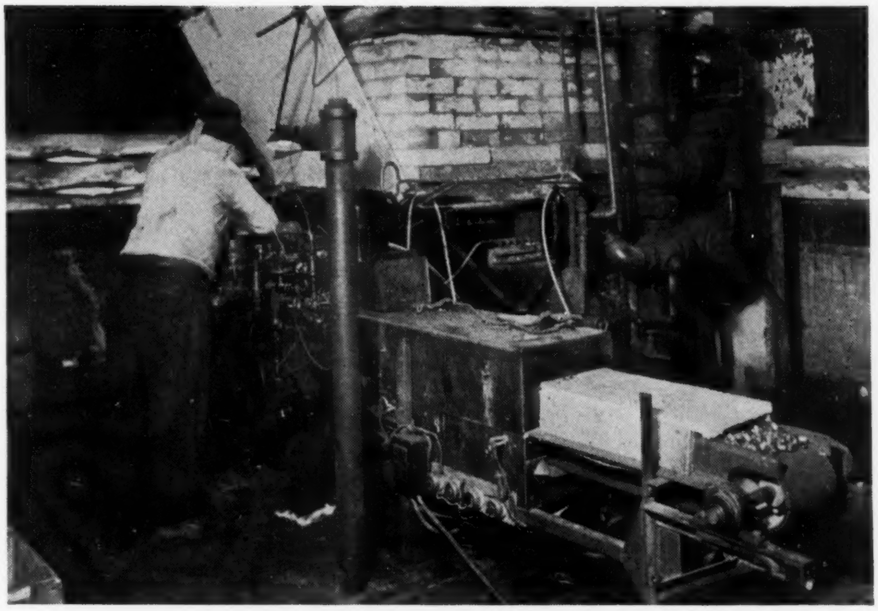
According to a little story of this plant written by Bernard Gardiner, it was "back in 1866—the year after Abraham Lincoln was assassinated—a little concern started in 'on a shoe string' to manufacture gas-burners, jewelers blowpipes, jewelers burners, gas-stoves, chandelier trimmings, and sundries.

It was the day of stove-pipe hats and mutton-chop whiskers—long before the advent of safety razors and incandescent lamps. That same humble concern is today the largest manufacturer of incandescent-lamp bases in the world."

When first organized it was known as Mooney and Gleason. The story is told that Mooney chased Gleason out of the works with an ax and Gleason migrated to New York State where he became a millionaire manufacturer. They first began to manufacture the bases for electric incandescent lamps in 1887. The present modern, well-equipped plant was built in 1918.

The visitor to this plant will see the punching and forming of the brass ferrules and eyelets which form the center contact and the glass furnaces where glass is melted and poured to form the center of the base and insulator between the ferrule and the eyelet. The base machine which operates at each furnace is a highly developed mechanism and can turn out an average of 11,000 bases per hour. During 1937, 750,000,000 complete bases of all sizes were turned out. Raw materials in the form of 5,000,000 pounds of sheet brass and 5,000,000 pounds of glass materials, manganese,

lime, soda, and bottle glass were required. The illustration in the right-hand corner of this page shows one of the furnace and base-machine units in operation.



GLASS FURNACE AND BASE MACHINE IN OPERATION AT THE PROVIDENCE BASE WORKS OF THE GENERAL ELECTRIC CO.

The Gorham Manufacturing Co.

Providence is fortunate to number among its industries the Gorham Manufacturing Company, whose master craftsmen have been turning out fine silver for over a century. The firm was founded in 1831 by Jabez Gorham who had prepared himself for this venture by a long apprenticeship in the art of fashioning metals and the making of silverware. From this beginning the present plant, located about two miles from the center of Providence, grew. It occupies about 37 acres and has 400,000 square feet of workshop floor space.

Here the visitor will see the making of fine silverware from the forming of the intricate steel dies to the final polishing. He will see the spinning and assembly of hollow-ware, the famed master craftsmen, who spend their lives learning their art, at work hand chasing and engraving ecclesiastical goods. In another department will be seen the bronze foundry where statuary, urns, plaques, and architectural bronze are made. Here, all of the bronze work for Radio City in New York was produced.

Other trips are being planned to the plants of the U. S. Rubber Company, the Narragansett Brewing Co., and the Esmond Mills, about which further details will be given in the next issue.

Entertainment

While the program for the entertainment features of the meeting is still in the formative stage, a luncheon is scheduled for Oct. 5 at the Biltmore Hotel for both men and women, at which it is hoped Dr. Henry M. Wriston, president of Brown University, will be the speaker.

On October 6 there is an automobile trip to Newport planned for the women. Upon their return they will join with the men in that most famous of Rhode Island institutions, a real old-fashioned clambake.

Committees

The General Committee was given in our July issue (in that list, by the way, the name of J. D. Robertson appeared, unfortunately, as Robinson) so this time we think a little glory should go to the chairmen of the subcommittees—usually unsung.

Mrs. Clarke Freeman, Ladies Committee; Prof. Zenas R. Bliss, Technical Events Committee; John D. Eldert, Plant Trips; Prof. William H. Kenerson, Reception; William A. Kennedy, Information and Registration; Prof. Paul N. Kistler, Hotels; Norman D. MacLeod, Entertainment; Chester T. Morey, Local Finance; and Laurence E. Wagner, Publicity.

Technical Program

And lest it be thought this Fall Meeting is all plant visit and clambake, we hasten to tell you that the program of papers presents a complete array of contributions for the most technical minded! Fuels, machine-shop practice, textiles, rubber, power, management, iron and steel—sessions in all of these fields fairly bristle with papers bearing important titles and carrying their load of valuable data. They won't let us give you these titles now—want to keep you in suspense—so have a weather eye out for that technical program. It will be "shown" in the September issue.

HAND-CHASING A SILVER VASE AT THE PLANT OF THE GORHAM MANUFACTURING CO. IN PROVIDENCE

Booklet Available to A.S.M.E. Members Entitled "The Significance of Management—A Symposium"

Statements Made by American Executives in Advance of Management Congress in Washington, D. C., Sept. 19–23

VIEWS expressed in a symposium in advance of the Seventh International Management Congress to be held in Washington, D. C., Sept. 19–23, by representative executives of American corporations are printed in a booklet entitled, "The Significance of Management—A Symposium." Contributors to the symposium were asked to state the contributions, responsibilities, and opportunities as they exist today.

As one reads the statements, he cannot but recognize the widened sense of responsibility which is characteristic of the leaders of enterprise today. The words represent the distilled essence of business experience gained over many years, tempered by great economic forces, challenged by political movements, humbled by a new social awareness, according to Lewis H. Brown who is the author of the foreword.

The Congress is under the auspices of the International Committee of Scientific Management, of which the Right Honorable Viscount Leverhulme of Great Britain is president, and Harry Arthur Hopf, member, A.S.M.E., deputy president. The chairman of the Co-ordinating Committee directing the Congress is William L. Batt, past-president, A.S.M.E. The National Management Council, which represents the United States in the Congress, is made up of several organizations, among which are the A.S.M.E., A.M.A., A.C.M.E., S.A.M., and others.

Booklet and complete details of the Congress may be obtained from N. W. Barnes, executive secretary, Seventh International Management Congress, 347 Madison Ave., New York, N. Y.

ST. LOUIS SECTION MEMBERS RESPONSIBLE FOR SUCCESS OF MEETING

(Back row, left to right: R. M. Boyles, treasurer, G. V. Williamson, A. J. Leussler, R. W. Merkle, A. L. Heintze, R. C. Thumser, D. E. Dickey, C. B. Brisco. Front row, left to right: W. E. Bryan, vice-chairman; Jesse L .Best, Ernest Hartford, ass't secretary, A.S.M.E.; C. J. Colley, chairman; R. M. Pease, D. Larkin, E. H. Sager, secretary. Not present: G. L. Shanks, L. C. Farquhar, E. H. Tenney, A. K. Howell, A. Vigne.)

St. Louis Welcomes the A.S.M.E.

Most Complete Program of Technical Sessions, Inspections, and Entertainment Provided at 1938 Semi-Annual Meeting Held June 20–23

TRULY NATIONAL in scope was the 1938 Semi-Annual Meeting of The American Society of Mechanical Engineers in St. Louis, Mo., which opened Monday, June 20, and continued through Thursday, June 23. At the headquarters in the Hotel Statler, 630, some coming from as far as Massachusetts and California, were registered by a staff supplied through the courtesy of the St. Louis convention Bureau. Technical sessions saw the presentation of papers and discussions by engineers from all parts of the country.

The success of the meeting in all its phases was due to the great care with which the St. Louis Section, host for the affair, worked out every smallest detail for the comfort of the visitors and for the smooth functioning of all the sessions. Even the local weatherman did his part by keeping away the rain and providing cool weather during the week of the meeting, very unusual for St. Louis at that time of year.

Though the convention was scheduled to open Monday afternoon at 4 o'clock with a Business Meeting, members of Council, of the Committee on Local Sections, and of the Nominating Committee, began arriving as early as Saturday evening. W. Lyle Dudley from Seattle was the first out-of-town member in on Saturday evening with Harte Cooke from Auburn, N. Y., a close second. Sunday morning saw the arrival of Harvey N. Davis, President of the Society, J. N. Landis from New York, James M. Todd from New Orleans, L. W. Wallace from Chicago, S. B. Earle from South Carolina, F. O. Hoagland from Connecticut, K. M. Irwin from Philadelphia, J. W. Haney from Nebraska, W. R. Woolrich from Texas, and many others. Among these was Elmer H. Neff, life member from New York, who, since joining the A.S.M.E. in 1898, has not missed a single Annual Meeting and only one Semi-Annual Meeting.

Committee and Council Meetings

First committee to go into action was the Committee on Local Sections early Sunday morning with W. R. Woolrich, D. B. Prentice, A. J. Kerr, J. N. Landis, and Ernest Hartford present. At the all-day session, among many items of business, the committee decided that in lieu of meeting in Providence, R. I., in October, members of the committee will visit the various local sections throughout the country. It is expected that Dean Woolrich, chairman, will visit local sections in Michigan, Illinois, Wisconsin, and all states west of the Mississippi, while other members of the committee will visit the remaining local sections. They also recommended to Council the advisability of expanding the Peoria Section to include all of Central Illinois and the change of its name to the Central Illinois Section. Also the eastern half of Arkansas, including Little Rock, was transferred from the Mid-Continent Section to the Memphis Section. At two o'clock on Sunday afternoon the Executive Committee of Council met. Routine details were considered in preparation for the informal conference of Council and members which took place later in the afternoon. Council reconvened early on Monday morning and, with time out only for a reception luncheon at noon and dinner in the evening, did not adjourn until twenty minutes to twelve that night. A report of the work of Council and of the Business Meeting will be found on pages 646–648 of this issue.

Open hearings were held all day Monday and Tuesday by the Nominating Committee. After reading the recommendations received from members and local sections throughout the country and listening to the oral presentations of those present, the committee, consisting of F. M. Gibson, Brooklyn, N. Y. (chairman), T. H. Beard, Bridgeport, Conn., H. L. Whittemore, Washington, D. C., F. L. Wilkinson, Knoxville, Tenn. (secretary), F. C. Hockema, West Lafayette, Ind., R. M. Boyles, St. Louis, Mo., and G. L. Sullivan, San Francisco, Cal., carefully considered the merits of every proposed candidate at a closed meeting on Wednesday and at 5:30 o'clock that evening handed a list of the names of the nominees to Secretary C. E. Davies. The list of candidates and their biographies will be found on pages 649–652.

Other committees which met during the course of the meeting were those on Aims and Objectives, Relations With Colleges, Fluid Meters, and Subgroup Five on Welding of Branch Connections.

Authors and Chairmen Talk Things Over

Particularly impressive were the dinner and the breakfasts attended by authors and chairmen prior to the day's technical sessions. The dinner on Monday evening, presided over by James H. Herron, served as an example of the informal dignity which prevailed there and at the subsequent breakfasts. After a brief talk by the presiding officer, who represented the President of the Society, on the history of technical sessions in the A.S.M.E. and their importance in the dissemination of engineering knowledge, he presented gavels to the chairmen of the various sessions who in conjunc-

MEMBERS OF ST. LOUIS MEETING LADIES' COMMITTEE

(Back row, from left to right: Mrs. R. W. Merkle, Mrs. R. M. Pease, Mrs. R. C. Thumser, Mrs. Jesse Best, Mrs. G. L. Shanks, Mrs. A. Heintze, Mrs. L. C. Farquhar. Front row, from left to right: Mrs. A. S. Langsdorf, Mrs. D. E. Dickey, Mrs. E. H. Sager, chairman, Mrs. E. H. Tenney, Mrs. C. J. Colley. Committee members not present: Mrs. David Larkin, Mrs. A. K. Howell, Mrs. Lowell Andrews, Mrs. W. E. Bryan).

St. Louis Meeting in Pictures

A Pictorial Record of the 1938 Semi-Annual Meeting

(1) Committee on Local Sections in real action with Ernest Hartford, D. B. Prentice, W. R. Woolrich, A. J. Kerr, and J. N. Landis; (2) Speakers' table at Council Luncheon showing A. A. Potter, A. S. Langsdorf, L. W. Wallace, H. N. Davis, C. J. Colley, and J. H. Herron; (3) C. E. Davies talks with F. O. Hoagland and H. N. Davis; (4) Having their pictures taken are L. F. Zsuffa, T. H. Wickenden, and W. R. Woolrich; (5) Executive Committee of Council deciding some momentous questions; (6) The ladies do some posing too; (7) The head men of the St. Louis Section, C. J. Colley and E. H. Sager; (8) W. G. Christy, A. S. Langsdorf, and H. O. Croft; (9) J. N. Landis talks to James M. Todd, W. R. Woolrich, and S. B. Earle; (10) Entertainment at the Smoker—the picture is self-descriptive; (11) R. M. Barnes, Elmer H. Neff, M. D. Engle, and H. E. Bumgardner; (12) A. G. Christie, candidate for 1938–1939 President of the Society being congratulated by R. M. Boyles, member of the Nominating Committee. Pictures 3, 4, and 12 from *St. Louis Star-Times* and 7, 8, and 11 from *St. Louis Daily Globe-Democrat.*

tion with the recorders conferred with the various authors on the presentation of the papers.

Technical Sessions

The latest advances and developments in mechanical and industrial engineering were well covered in the 15 technical sessions at which 35 papers were presented by 46 authors, individually or jointly. Since most of the papers have been or will be published in MECHANICAL ENGINEERING or the A.S.M.E. Transactions, this space will be devoted to a description of the high lights of the sessions. Two sessions, one on time study and the other on fuels, opened the technical part of the meeting on Monday evening.

Management

The session on time study was held on Monday evening by the Management Division jointly with the Society for the Advancement of Management. Ralph M. Barnes gave a talk on the practical applications to motion study of a method employing photoelectric cells, making it possible to study and time movements to thousandths of a minute. A. B. Segur, with the able assistance of his wife and a member of the audience, demonstrated various principles of motion analysis which he has applied successfully in industry.

Fuels

At the other session on Monday evening which dealt with fuels, an improved method of measuring smoke density was proposed by H. E. Bumgardner in his paper. Discussions on the subject were presented by W. G. Christy and A. G. Christie. Unable to be present, H. K. Kugel of Washington, D. C., R. A. Sherman of the Battelle Institute, L. S. Marks and C. H. Berry, of Harvard University, J. L. Hodges of Jersey City, and Osborn Monnett of Detroit, sent in written discussions which were read by M. D. Engle, chairman of the session. Other papers presented included one on a downdraft conversion burner for domestic furnaces by J. R. Fellows and another on coal carbonization and its relation to the smoke problem by M. D. Curran.

On Wednesday morning, a second fuels session, under the joint auspices of the Fuels and Power Divisions took place. The many discussions of L. C. McCabe's paper on the preparation of Illinois coals attested to the interest being shown by engineers in fuels and their efficient use. Other pertinent discussions were developed by the papers on fuels for industrial furnaces by M. H. Mawhinney and on the power-plant requirements of a distillery by Hiram L. Walton.

Power

At the boiler-feedwater session on Tuesday morning, great interest was shown in carbonaceous zeolites, a new chemical for conditioning boiler feedwater, which was described by H. L. Tiger. S. E. Tray presented a method suitable for use in the field of continuously measuring impurities. But the interesting part of the session occurred when R. M. Hitchens gave a paper in which he showed that sodium sulphite can be used without any harmful effects in high-pressure steam boilers, proving his point by citing examples of actual usage in power plants; this conclusion was exactly opposite to that reached by F. G. Straub in a preceding paper, his reasons being based on experiments carried out in the laboratories of the University of Illinois.

Flanges received their share of attention on Thursday morning when tests on heat-exchanger flanges made by D. B. Rossheim, E. H. Gebhart, and H. G. Oliver, were described by J. D. Mattimore. Applications of the recent Waters, Rossheim, Wesstrom, and Williams flange-design formulas to a valve-bonnet joint were given in a paper by J. D. Mattimore, H. O. Smith-Petersen, and H. C. Bell.

Railroad

The railroad sessions drew a goodly crowd. T. V. Buckwalter presented data on the testing of locomotive axles in the laboratory while John R. Jackson discussed the characteristics and limitations of the relationship between exhaust pressure and draft in a steam locomotive. In the afternoon, Albert Vigne described an oil-bath-lubricated bearing which will prevent hotboxes on locomotives and coaches; and S. J. Needs gave a mathematical explanation for the discrepancy between observed and theoretical frictions in heavily loaded bearings.

Process Industries

A method was suggested by C. E. Mason at the Tuesday morning session of the Process Industries Division for concrete representation of industrial processes by an easily visualized and comparable form of liquid-levels system. Following him, A. F. Spitzglass in a comparative analysis of automatic-control theories showed that they may be grouped under four basic components, discussing each one separately. In the afternoon, John M. DeBell reviewed the outstanding mechanical properties of various plastics and their applications in the field of mechanical engineering. Formulas developed by J. C. Witt for use in the proportioning of materials in process engineering were given in his absence by A. L. Heintze. These formulas make it possible to eliminate many preliminary calculations in the proportioning of various materials.

Hydraulic–Power

A joint session was held Tuesday afternoon under the auspices of the Hydraulic and Power Divisions at which the operating methods and problems of a combined hydro- and steam-electric system were discussed by H. L. Harrington. Following this, John Van Brunt reviewed development in designs of high-pressure, high-capacity steam-generating units and the problems encountered in designing them.

Apprenticeship

Under the auspices of the Committee on Education and Training for the Industries and the Management Division, Wednesday morning's session saw the presentation of a paper by Homer L. Humke on the apprenticeship-training program being used at Servel, Inc. Those taking part in the discussion which followed included Warner Seeley, Elmer H. Neff, R. M. Barnes, C. J. Freund, W. W. Freeland of Montreal, Canada, E. J. Abbott, L. W. Wallace, and F. C. Jeffrey, assistant superintendent of the St. Louis Board of Education. It was the contention of the discussers that the government should do something about the apprentice-training situation in cooperation with the country's manufacturers. The proposed plan was compared with those in use today in England and Russia.

Machine-Shop Practice

Welding was the topic of the session on Wednesday morning at which Erik Oberg presided. A. K. Seemann gave an explanation of a method of localized surface hardening by means of an oxyacetylene torch. The application of electric-arc and oxyacetylene welding to plant maintenance and repairs was considered in a talk by H. R. Wass. Finally, E. W. P. Smith compared the costs of electric-arc welding with other methods of fabrication.

Surface finishes furnished the subject for the Thursday morning session at which J. R. Weaver, chairman of the Committee on the Standardization of Classification and Designation of Surface Qualities, reported on the work of the committee. After five years, the committee has concluded that there is nothing smooth, since even a highly lustrous surface will, if properly examined, reveal numerous irregularities. Therefore, the committee recommends that surface quality be classified into 14 degrees of roughness. The completed report, which has been submitted to all members of the committee for their final approval is expected to be ready for submission to industry for its use not later than July 15. Other papers at the same session were presented by H. F. Kurtz on the use of optical projection for the rapid checking, measuring, and classification of different materials and by E. J. Abbott on the different types of instruments available for surface measurements together with their advantages and disadvantages.

Iron and Steel

The Steel Division held a session on Thursday morning jointly with the American Foundrymen's Association. The importance of maintenance in foundry operation was ably described by Wm. Carter Bliss and some engineering aspects of cast iron were discussed by C. H. Morken. Plastic bronze made from only three copper-tin alloys can be used to cover almost any bearing application according to a paper presented by C. C. Morgan.

Smoke-Abatement Luncheon

St. Louis passed its first smoke ordinance in 1867 and, periodically, the subject of enforcement of similar ordinances has been brought to the attention of the citizens of the city. In the last two years, a new ordinance, drafted with the aid of the members of the St. Louis Section, A.S.M.E., was put into effect and under the able direction of Raymond R. Tucker has proved successful. Therefore, it was more than appropriate that a luncheon on Tuesday featured Mr. Tucker as the guest speaker.

After being introduced by Harvey N. Davis, President of the Society, who presided, Mr.

Tucker gave thanks to those members of the A.S.M.E. who helped to draft the present ordinance and then reviewed the history of smoke legislation in St. Louis.

Calvin W. Rice Lecture

Warning that the world cannot afford to continue the extravagant use of its metals, was given by William Robb Barclay, noted English metallurgist, in the fourth Calvin W. Rice Lecture. Because of illness, Dr. Barclay was unable to go to St. Louis and, therefore, his paper was read on Tuesday afternoon by T. H. Wickenden of New York. The paper, besides showing the possibilities of conservation without a reduction in the use of metals by the development of new longer-life metals and alloys, also reviewed existing ferrous and nonferrous metals and their applications in industry. The lecture will be published in two installments in Mechanical Engineering, one in this issue, pages 595 to 600, and the second in next month's.

WILLIAM ROBB BARCLAY

National Defense Meeting

In a talk presented before an audience of 350 on Tuesday evening, Maj. John K. Christmas, U. S. Army, described the manufacture of tanks at the Rock Island Arsenal, illustrating his talk with motion pictures and slides. In his introduction he called the attention of those present to the fact that "a few of you have contributed, directly and indirectly, to the development of the tank and, therefore, you may be interested to know how it now stands and how it is produced." Some parts obtained from private manufacturers, according to Major Christmas, are difficult to secure from a procurement standpoint, both in peace and war, such as the armor plate, the engines, the transmissions, and the rubber parts. The paper will be published in a subsequent issue of Mechanical Engineering.

Smoker

Following Major Christmas' talk, the group adjourned to the ballroom where they took part in all kinds of games of chance, being supplied beforehand with a plentiful supply of greenbacks and Missouri tax tokens. Provender in the way of pretzels and potato chips was furnished and thirst was quenched with a product, called Budweiser, made at the Anheuser-Busch plant. Those who lost their fortunes at the gaming tables, were cheered up with songs and dances by entertainers from stage and radio. The smoker committee, anxious to retrieve the thousands of dollars of greenbacks which it had distributed so freely at the beginning of the evening, offered to buy some back for cash from the three who had the largest amount in their possession at the conclusion of the affair.

Banquet

The setting for the banquet on Wednesday evening in the grand ballroom of the Hotel Statler was especially fine. Each table was decorated with a colorful bouquet while the speakers' table, festooned on all sides with garlands of flowers, had a large centerpiece of hundreds of blossoms. The gold of the walls and ceiling reflected the soft yellow lights from chandeliers and wall-bracket lamps. But the most striking thing in the room was the banner behind the speakers' table with its gold A.S.M.E. insignia on a field of deep blue.

It was an occasion long to be remembered by the 350 members, guests, and ladies who were present. During the serving of the dinner, music was played by the Steindel Ensemble.

Seated at the speakers' table were Dean A. S. Langsdorf who acted as toastmaster, President Harvey N. Davis, Maj. James H. Doolittle, Charles J. Colley, chairman of the St. Louis Section, Harte Cooke, Mrs. H. N. Davis, Mrs. J. H. Doolittle, Dean A. A. Potter, E. W. Burbank, Mrs. A. S. Langsdorf, Mrs. H. Cooke, Dean S. B. Earle, Dr. E. J. Abbott, Kenneth H. Condit, W. Lyle Dudley, and C. E. Davies. Mr. Colley in a short speech welcomed the A.S.M.E. to St. Louis and then presented Dean Langsdorf as the toastmaster for the evening. After a few words on his part, the toastmaster introduced Harte Cooke of the Board of Honors and Awards who then presented Major Doolittle to President Davis as the fourth recipient of the Spirit of St. Louis Medal. It was awarded, as Doctor Davis said, "for meritorious service in the advancement of aeronautics."

Following the presentation of the medal and its acceptance by Major Doolittle, Dean Langsdorf introduced Mrs. L. C. Nordmeyer, widow of the A.S.M.E. member who was chairman of the St. Louis Section at the time of the 1920 meeting. Dean G. L. Sullivan was then asked to say a few words about the 1939 Semi-Annual Meeting in San Francisco during the week of July 10, at which time the A.S.C.E., A.I.E.E., and A.I.M.E. will also meet there. Then E. H. Sager, secretary of the St. Louis Section, handed to President Davis a check made out for the amount which remained over from the 1935 Aeronautic Division meeting in St. Louis in 1935. If accepted by Council, the money will be used to establish a Junior Spirit of St. Louis Award of $50 in cash to be given to a Junior member of the Society at the same time as the other award, that is, every three years. Then C. E. Davies, Secretary of the Society, announced the names and introduced those who were present of the members selected that afternoon by the Nominating Committee to be the officers of the Society next year.

PRESIDENT DAVIS PRESENTS MAJOR JAMES H. DOOLITTLE WITH THE SPIRIT OF ST. LOUIS MEDAL

A. G. Christie, professor of mechanical engineering at Johns Hopkins University, Baltimore, Md., was selected for the presidency. Vice-presidents nominated for two-year terms were W. Lyle Dudley of Seattle, James W. Parker of Detroit, and Alfred Iddles of New York. H. H. Snelling of Washington, D. C., was named as a vice-president to serve one year. Managers of the Society to serve three-year terms included Clarke Freeman of Providence, W. R. Woolrich of Austin, Texas, and W. H. Winterrowd of Chicago.

Speaker of the evening was President Davis, who in his talk on "Engineering and Health" gave a dramatic recital of the engineer's achievements having significance to human happiness and comfort. After calling the roll of the engineer's obvious contributions to public health through sanitation, refrigeration, and similar services, Dr. Davis emphasized the raised standard of living and greater satisfaction in one's work that has resulted from the activities of the engineer. He pointed to an opportunity for the engineer to improve mental health by striving for reduction of economic instability to achieve this. Dr. Davis pleaded for more engineering-trained men in positions of industrial leadership, these men to be possessed of social understanding and vision as well as of sound engineering judgment.

Inspection Trips

Much interest was shown in the inspection trips arranged to the various plants in and near St. Louis. Among these were the Cahokia power plant, the largest steam-electric plant in the Mississippi Valley; the modern pipe-fabricating plant of the Midwest Piping and Supply Co.; the Laclede-Christy Clay Products Co. plant where were seen the various processes in the manufacture of refractories and sewer pipe; the St. Ellin Mine in O'Fallon,

Ill., which is equipped with the latest in coal washers in order to conform to the requirements of the St. Louis smoke ordinance; the Anheuser-Busch brewery which has the distinction of being the largest one in the world; the Busch-Sulzer Bros. Diesel Engine Co. factory where visitors saw on exhibition the first commercial Diesel in the world, built in St. Louis in 1898; the Wood River Refinery of the Shell Petroleum Corporation, one of the largest refineries in the world; the Western Cartridge Co. plant, the largest of its kind in the world; the Owens-Illinois Glass Co. factory in Alton, Ill., the largest glass-container manufacturing plant in the world; the St. Louis Fisher Body Company plant; the by-product coke plant of the Laclede Gas Company; the Howard Bend branch of the St. Louis water works with pumps capable of taking in millions of gallons of water each day from the Missouri River; the Century Foundry Co. where a large variety of work is handled, as much as possible, on a mass-production basis; and the modern wire-rope factory of the Broderick & Bascom Rope Co.

St. Louis Municipal Opera

Visits were made on Monday and Thursday evenings to the St. Louis Municipal Opera to see the presentation of the operetta "White Horse Inn" in the natural outdoor ampitheater of Forest Park.

And there spread across the stage for at least 120 feet was a street scene transplanted from a spot in the Tyrol. This was the first time in its twenty years of existence that the Opera employed such a large stage setting.

Women's Activities

Following an informal reception to the visiting women at headquarters in the Hotel Statler on Monday morning, lunch was served, and then a visit was paid to the old and new St. Louis Cathedrals. In the evening, the women attended the Municipal Opera to see "White Horse Inn." On Tuesday, following a luncheon at the Castilla Tea Room, an automobile trip was made to Forest Park and the Washington University campus. It was then continued for a sundown trip through the picturesque St. Louis suburban countryside to St. Albans farm on the Missouri River where dinner was served.

An inspection of the St. Louis Dairy was made on Wednesday. After luncheon at Garavelli's Restaurant, the usual meeting place of the St. Louis Section, the women made a tour of the suburban residential districts where they were given an opportunity to visit the beautiful private homes and their gardens. Thursday morning found them at Shaw's Garden where in the plant-curiosities house were found such freaks of floral life as the artillery plant which shoots seeds from its pods; the dumb cane, a bite of which would swell the tongue and stop one's speech; the crown of thorns from Madagascar and other strange and beautiful specimens. At noon, a luncheon and fashion show was held at Stix, Baer & Fuller's department store.

A.S.M.E. Council and Business Meetings at St. Louis

PRECEDING THE 1938 Semi-Annual Meeting of The American Society of Mechanical Engineers, Hotel Statler, St. Louis, Mo., the Executive Committee of the Council met on Sunday afternoon, June 19, 1938, at 2:00 p.m., with President Harvey N. Davis in the chair and the following committee members present: James M. Todd, Kenneth H. Condit, Harte Cooke, advisory members; K. M. Irwin, chairman of the Finance Committee; W. R. Woolrich, chairman of the Local Sections Committee; and C. E. Davies, Secretary. Others present were Frank O. Hoagland, W. Lyle Dudley, E. W. Burbank, Jiles W. Haney, and Ernest Hartford, assistant secretary.

The Executive Committee voted to appoint President Davis as A.S.M.E. representative on the John Fritz Medal Board for a four-year term expiring in 1942.

Registration Fees

The question of registration fees at meetings of the Society was discussed and in view of the large interest in this question among the membership, the Executive Committee asked that the matter be discussed at the Local Section Conferences in the fall.

Other administrative matters taken up concerned resignations, reinstatements, and other recommendations of the Board of Review. The maturity date on a mortgage owned by the Society was extended for three years. The Committee on Professional Divisions was asked to investigate the matter of engineering conferences and exhibitions held by educational institutions.

Appointments Reported

The following appointments were reported: Special Research Committee on Mechanical Springs, T. R. Weber; Sectional Committee on Standardization of Letter Symbols and Abbreviations for Science and Engineering, S. A. Moss; Joint Committee with A.S.T.M. on Development of Applications of Statistics in Engineering and Manufacture, John S. Tawresey; American Association for Advancement of Science, Section M, R. L. Sackett and R. F. Gagg; Woman's Auxiliary—Representatives: James H. Herron and R. F. Gagg; Annual Meeting Verein deutscher Ingenieure, Stuttgart, Germany, May 27–31, Conrad Matschoss; Semi-Centennial Celebration Founding of Utah State Agricultural College, June 5–7, Julius Billeter.

The Council Meeting on Sunday

The Council met in informal discussion session on Sunday afternoon, June 19, 1938, at the Hotel Statler in St. Louis, following the meeting of the Executive Committee. The meeting which continued through the evening, was attended by members of Council, chairmen of standing committees, and a number of other interested members of the Society. Its purpose was to give the members of the Council full opportunity to raise questions that were not on the regular order of business for the meeting and thereby become more fully informed about the work of the Society.

In the afternoon the Parker case was discussed. In the evening the discussion veered to the special Society problems arising from the widespread technical interests of the members.

The Council Meeting on Monday

The formal meeting of the Council was held on Monday morning, June 20, at the Hotel Statler. The President presided and other members of the Council who were present throughout the sessions of the day, which finally adjourned at 11:30 p.m., were: A. A. Potter, James H. Herron, James M. Todd, Frank O. Hoagland, Harte Cooke, L. W. Wallace, W. Lyle Dudley, Walter C. Lindemann, Edward W. Burbank, Kenneth H. Condit, Carl L. Bausch, Samuel B. Earle, K. M. Irwin, C. B. Peck, W. R. Woolrich, and C. E. Davies, Secretary. About twenty members of the Society attended from time to time during the day's meetings of the Council.

Tribute to Dean Brigman

The Council adopted the following statement of tribute to Dean Bennett M. Brigman, prepared and presented by Past-President A. A. Potter, and then rose for a moment's silent tribute.

BENNETT MATTINGLY BRIGMAN

Bennett Mattingly Brigman was born in Louisville, Kentucky, on February 25, 1881, and died at his home in the same city on February 8, 1938.

He was educated in the Louisville public schools, the DuPont Manual Training High School, University of Kentucky, and University of Louisville, B.S. 1908, M.S. 1912.

He acted as engineer of tests for the L.&N. R.R. from 1902–1904, taught at the University School 1904–1907, at the DuPont Manual Training School 1907–1910, and at the University of Louisville part time from 1912–1916 and full time since 1916. In 1923–1924 he laid plans for the organization of the Speed Scientific School. On March 4, 1924, B. M. Brigman was appointed Dean of the Speed Scientific School and held this position continuously until his death.

Dean Brigman was active in educational, engineering, and scientific societies. He was a member of the Council of the S.P.E.E. (1925–1928) and was its vice-president in 1934. He was an active member of the A.S.M.E., a manager of this Society (1934–1937) and a vice-president in 1938. He also held membership in the A.A.A.S., A.S.T.M., A.I.E.E., N.S.P.E., and A.A.U.P. He was a member of the Regional Committee of E.C.P.D. on Engineering Schools. He was interested in Civic affairs and served as an officer of a Service Club in Louisville, was a member of a Planning and

Zoning Board, and of a Smoke Abatement Committee in the same city.

The friendly personality and the untiring energy of Dean Brigman left a favorable impression on all who came in contact with him.

In the untimely passing of Dean Brigman the Council of the A.S.M.E. has lost a devoted and capable member. His friendly presence will be missed by his many friends at the meetings of this Council and of the other engineering groups to which he had so faithfully devoted the best of his talents.

* * * *

William A. Shoudy, former vice-president of the Society, was appointed by the Council to fill the vacancy caused by Dean Brigman's death through the close of the 1938 Annual Meeting.

The Budget

The Council devoted a large amount of time to the statement of income and expenses and the balance sheet for May 31, and continued from that discussion into that pertaining to the budget for the fiscal year commencing October 1, 1938. The budget as adopted appears on page 648 of this issue.

Applications for Grade of Fellow

The Committee on Admissions submitted recommendations of 15 applicants for the grade of fellow, which were ordered to letter ballot to close on July 15.

A special certificate and a special pin for the fellow grade were adopted in tentative form. Modifications in the form of certificate for members were also approved.

Schedule of Meetings Approved

The following schedule of meetings of the Society as approved by the Executive Committee, was entered into the record:

Fall Meeting, Providence, R. I., October 5-7, 1938.

Annual Meeting, New York, N. Y., December 5-9, 1938.

Spring Meeting, New Orleans, La., February 23-25, 1939.

Semi-Annual Meeting, San Francisco, Calif., week of July 10, 1939.

Fall Meeting, New York, N. Y., September 4-7, 1939. Jointly with The Institution of Mechanical Engineers.

Annual Meeting, New York-Philadelphia, December 4-8, 1939.

Registration Committee Continued

The Registration Committee of the Society was continued as a special committee of the Council for a three-year term.

Membership

The Council discussed the desirability of eliminating the provision in the by-laws by which membership in the local sections may be extended to nonmembers of the Society. This question was referred to the Local Sections Delegates Conference for further discussion before taking final action at the meeting of the Council in December.

The Council adopted rules 1 and 2 describing procedure for completing election of those student members who are promoted automatically to the junior grade. The amended rules as adopted appear on page 653.

Relationship With E.C.P.D.

A policy of relationship between the Society and the accrediting program of E.C.P.D. was adopted. This policy defines a school of accepted standing to be a school which has one or more engineering curricula approved by the E.C.P.D. New student branches may be installed only in institutions appearing on the E.C.P.D. accredited list for mechanical engineering and general engineering. Student branches in institutions not on the E.C.P.D. list are to be placed in a provisional status for a period not to exceed four years.

The Council authorized the establishment of a Committee on Education which, in general, will be concerned with policies of the Society having to do with formal processes of engineering education and specifically will formulate plans for a series of lectures on subjects of concern to practicing engineers.

Woman's Auxiliary

Recent revisions in the constitution of the Woman's Auxiliary of the Society were recorded.

The Parker Case

President Harvey N. Davis reported that the action commenced in December, 1936, by John Parker and certain members of The American Society of Mechanical Engineers against certain present and former members of the Society's Council and its officers and certain other persons with reference to the Engineering Index has resulted in a decision by the New York Supreme Court, New York County, which seems to be detrimental to the welfare of the Society as a whole. The President presented to the meeting a copy of the decision of the Court by Mr. Justice Black. The President further reported that he had been advised by Messrs. Root, Clark, Buckner & Ballantine, who were retained by the Society to defend the action, that in their opinion the decision was erroneous and that an immediate appeal should be taken.

The President stated that in his judgment it was imperative on the part of the Society to continue its vigorous defense of this action for the following reasons:

"1 The continuing welfare of the Society depends fundamentally on its ability to secure men of the highest caliber to serve on its Council and as its officers. It cannot, therefore, afford to let pass unchallenged a public statement, such as that made in this decision, that what a large number of its members regard as faithful, conscientious, unselfish, and, on the whole, gratifyingly effective service rendered to it by its Council over one of the most difficult six-year periods in its history, constituted such crass negligence as to make individual members of that Council liable for considerable damages. In a Society of this size there will always be differences of opinion. If Council members and officers, acting in good faith are to be exposed to court attacks by individual members of minority groups, and are not to be given the support of the Society in their efforts to have reasonable limits set as to what should be expected of them, with respect both to omniscience and to personal liability, it is going to be impossible to get distinguished and conscientious men to give their time and efforts to this or any other professional or learned Society. The suggestion that it would be advantageous to this Society, or to any of its members, to recover from its officers past expenditures amounting to about five per cent of its total expenditures over the period in question, at the cost of undermining the caliber of its management over an indefinite future is utterly short-sighted. The Society must, therefore, for its own good, press for a judicial review of this lower Court's decision.

"2 The Court's decision as to a compulsory letter ballot or meeting of the Society constitutes an interference with the internal management of the affairs of the Society which should not be accepted as a precedent without challenging its soundness in the higher courts.

"3 The cancellation by the Court of the Lease Agreement between the Society and Engineering Index, Inc., is most unfortunate from the Society's point of view. Under this Lease Agreement, Engineering Index, Inc., took over and is now publishing the Engineering Index Services. The Agreement has served the dual purpose of effecting the continuation of the Index services, which are of great value to the engineering profession, and at the same time of relieving the Society from all financial burden and risk in connection therewith. The decision of the Lower Court in this respect should be reviewed in the higher courts.

"4 The decision that the Society was without power to make the Lease Agreement with Engineering Index, Inc., also has wide implications. Unless this decision is reversed or clarified a serious question will be presented in any case where the Society might deem it wise to dispose of any of the rights or property which it has acquired in connection with its many activities."

After thorough discussion the Council approved the foregoing statement of President Davis and adopted the following resolutions:

Resolved, that the Society should continue to defend the action entitled "Clifford J. Stoddard, John Parker, and others against Charles M. Schwab, The American Society of Mechanical Engineers, and others" and that it should take an appeal from the judgment about to be entered upon the recent decision of Mr. Justice Black of the New York Supreme Court, New York County; and it is further

Resolved, that the firm of Root, Clark, Buckner & Ballantine, 31 Nassau Street, New York City, New York, be and hereby is authorized and directed to take all steps which such firm may deem necessary for the proper defense of the aforesaid action, including the prosecution of an appeal from the judgment to be entered upon the aforesaid decision.

Business Session

The Semi-Annual Business Session of the Society was called to order by President Davis at 4:30 p.m., June 20, 1938, at the Hotel Statler, St. Louis, Mo.

San Francisco, Calif., during the week of

July 10, was announced as the place for the 1939 Semi-Annual Meeting of the Society, when it is expected that other engineering societies will also be in session. San Francisco is holding an International Exposition at that time.

President Davis read a statement regarding the Parker case, the contents of which are as reported in the actions of the Council on page 647. The President also reported that resolutions had been adopted by the Council expressing the view that an appeal should be taken of the recent decision of Mr. Justice Black.*

On motion made and seconded, the Business Meeting unanimously voted the approval of the statement presented by President Davis and the adoption of the resolutions which had been previously adopted by the Council of the Society.

The President closed the meeting with a word of tribute to Dean Bennett M. Brigman, former vice-president of the Society, who died February 8, 1938.

* A copy of the opinion of Mr. Justice Black will be sent to any member of the Society who desires it.

A.S.M.E. Calendar

of Coming Meetings

September 12–16, 1938

Applied Mechanics and Hydraulic Divisions Cooperating in International Congress of Applied Mechanics
Cambridge, Mass.

September 22–23, 1938

Wood Industries Division Meeting
High Point, N. C.

September 28–30, 1938

Applied Mechanics Division (jointly with the Institute of Aeronautical Sciences)
Los Angeles, Calif.

October 5–7, 1938

Fall Meeting
Providence, R. I.

October 13–15, 1938

Fuels Division Meeting (jointly with A.I.M.E. Coal Division)
Chicago, Ill.

October 18, 1938

Joint Meeting with American Welding Society
Detroit, Mich.

December 5–9, 1938

Annual Meeting
New York, N. Y.

February 23–25, 1939

Spring Meeting
New Orleans, La.

ESTIMATED COST OF ACTIVITIES FOR 1938–1939 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, JUNE 20, 1938

Activity	Expense under committee supervision	Printing and distribution	Direct office expense	Total
Council	$ 5,800.00	.....	.....	$ 5,800.00
Library	9,118.00	.....	.....	9,118.00
A.E.C.	10,000.00	.....	.....	10,000.00
Finance Committee	110.00	.....	.....	110.00
Awards	475.00	.....	.....	475.00
Nominating Committee	500.00	.....	.....	500.00
Local Sections	23,125.00	.....	$ 7,971.67	31,096.67
Meetings and Program	6,600.00	.....	3,514.42	10,114.42
Professional Divisions	2,700.00	.....	3,514.43	6,214.43
Admissions	....	.....	6,672.61	6,672.61
Employment service	3,000.00	.....	.....	3,000.00
Student Branches	8,900.00	$ 5,000.00	7,276.87	21,176.87
Technical committees	1,000.00	.....	18,900.00	19,900.00
MECHANICAL ENGINEERING, text	....	26,000.00	10,965.00	36,965.00
Transactions	....	29,000.00	12,685.00	41,685.00
MECHANICAL ENGINEERING, advertising	....	17,100.00	21,274.32	38,374.32
Mechanical Catalog	....	23,000.00	16,161.68	39,161.68
Publications for sale	....	22,500.00	8,264.00	30,764.00
Retirement fund	2,700.00	.....	.....	2,700.00
Professional services	1,100.00	.....	.....	1,100.00
E.C.P.D.	850.00	.....	.....	850.00
Secretary's office	....	.....	16,610.00	16,610.00
Accounting	....	.....	13,650.00	13,650.00
General service	....	.....	25,990.00	25,990.00
General office expense	....	.....	16,750.00	16,750.00
Totals	$75,978.00	$122,600.00	$190,200.00	$388,778.00

ESTIMATED INCOME FOR 1938–1939 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, JUNE 20, 1938

Income	Actual 1936–1937	Estimate 1937–1938	Budget 1938–1939
Initiation and promotion fees	$ 8,726.90	$ 8,000.00	$ 8,000.00
Membership dues	215,908.83	205,000.00	200,000.00
Student dues	13,560.50	15,600.00	15,000.00
Interest and discount	12,315.13	9,100.00	9,500.00
MECHANICAL ENGINEERING, advertising	81,408.21	75,000.00	75,000.00
Mechanical Catalog advertising	48,865.63	49,000.00	49,500.00
Publication sales	54,359.45	50,000.00	50,000.00
Miscellaneous sales	1,966.75	1,500.00	1,500.00
Contributions, *Journal of Applied Mechanics*	875.00	1,025.00	500.00
Contributions, unrestricted	554.37	462.00	500.00
Registration fees	261.00	413.00	400.00
Sale of securities	— 117.12	.....	.....
Sale of equipment	233.50	200.00	100.00
Total income	$430,191.25	$407,300.00	$402,000.00
To be added to surplus	32,821.48	8,612.00	13,222.00
Balance for expense	$397,369.77	$398,688.00	$388,778.00

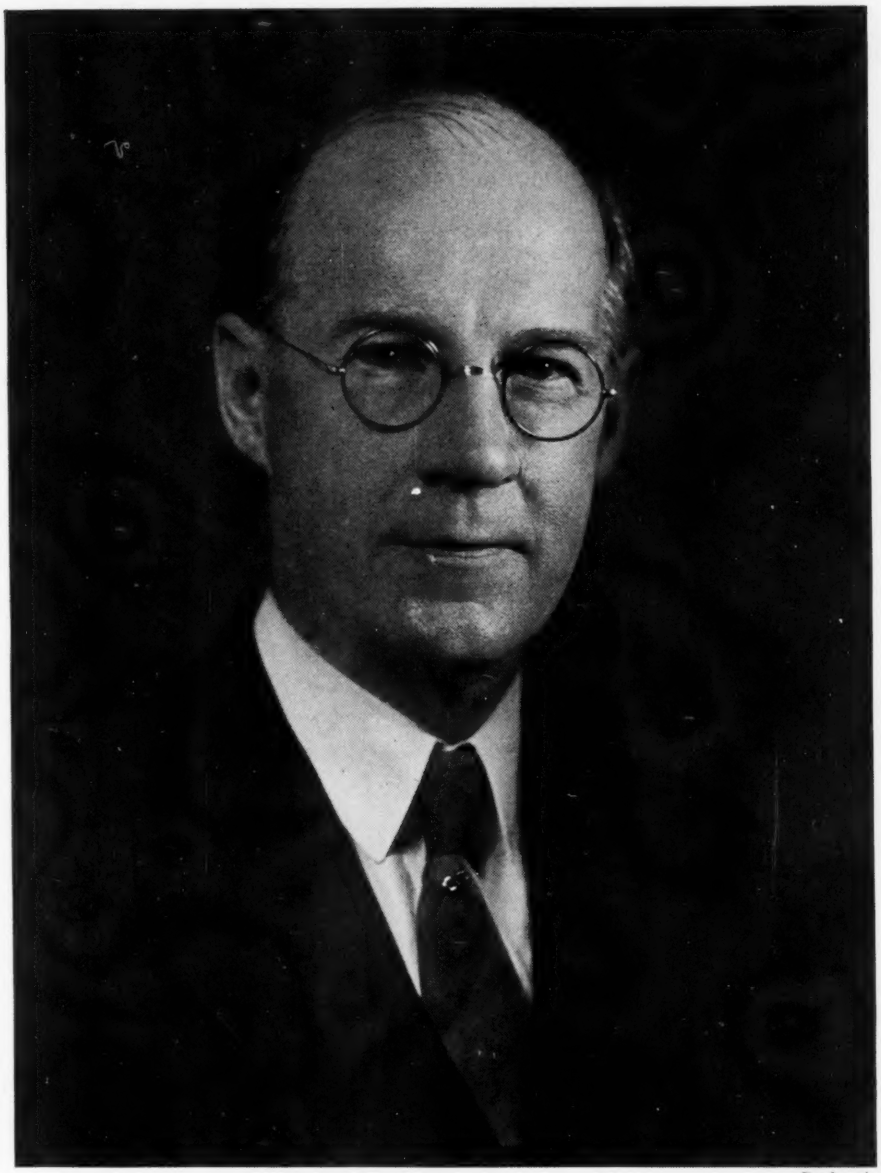
Tours Arranged for Those Attending the Applied Mechanics Congress

FOLLOWING the five-day technical sessions at M.I.T. and Harvard, members and their guests attending the Fifth International Congress for Applied Mechanics at Cambridge, Mass., Sept. 12–16, will proceed to Washington, D. C., and spend the day of Monday, Sept. 19, at the National Bureau of Standards, where they will be entertained at lunch by the Director. Taking the night boat to Old Point Comfort, Va., they will spend the next day at the Langley Field laboratories of the National Advisory Committee for Aeronautics, where they will be guests at lunch.

Those who wish to do so may continue and go on to Pittsburgh, Detroit, Niagara Falls, and Schenectady to visit the principal research laboratories and industrial works in those places.

A joint meeting of the I.A.S. and the Applied Mechanics Division, A.S.M.E., will be held on the Pacific coast, Sept. 28–30, in the Los Angeles area. Members of the Congress are cordially invited to attend these meetings and, if they desire, to present papers. Persons interested should communicate as soon as possible with Th. von Kármán, California Institute of Technology, Pasadena, Calif., or S. Timoshenko, Stanford University, Palo Alto, Calif.

A. G. Christie
for President



Bachrach

Nominated *for* A.S.M.E. OFFICERS IN 1938–1939

DURING the 1938 Semi-Annual Meeting of The American Society of Mechanical Engineers in St. Louis, Mo., June 20–23, A. G. Christie, consulting engineer, and professor of mechanical engineering at Johns Hopkins University, Baltimore, Md., was named by the Nominating Committee for the office of President of the Society for the year 1938–1939.

Vice-presidents nominated to serve on the Council of the Society for two-year terms were W. Lyle Dudley of Seattle, James W. Parker of Detroit, and Alfred Iddles of New York. H. H. Snelling of Washington, D. C., was selected as a vice-president to serve for one year.

Managers of the Society to serve on Council for three-year terms included Clarke Freeman of Providence, Willis R. Woolrich of Austin, Texas, and William H. Winterrowd of Chicago.

According to the Constitution, By-Laws, and Rules of the A.S.M.E., seven members and seven alternates are nominated to serve on a Regular Nominating Committee by each of seven groups of Local Sections, the Local Sections in each group being, as far as possible, contiguous geographically to each other. The membership then elects the members of the Committee, whose duty it is to select candidates for the executive offices to be filled for the next year.

The Nominating Committee for 1938 which made the nominations just listed consisted of F. M. Gibson, Brooklyn, N. Y., chairman, with Theodore Baumeister, Jr., New York, N. Y., alternate; T. H. Beard, Bridgeport, Conn., with W. L. Edel, Storrs, Conn., alternate; H. L. Whittemore, Washington, D. C., with G. E. Crofoot, Philadelphia, Pa., alternate; F. L. Wilkinson, Knoxville, Tenn., secretary, with R. M. Rothgeb, Raleigh, N. C., alternate; H. C. Anderson, Ann Arbor, Mich., with James Burke, Erie, Pa., and F. C. Hockema, West Lafayette, Ind., alternates; R. M. Boyles, St. Louis, Mo., with E. H. Sager, St. Louis, Mo., alternate; G. L.

Sullivan, Santa Clara, Cal., with H. J. Smith, San Francisco, Cal., and H. B. Langille, Berkeley, Cal., alternates.

A. G. Christie

ALEXANDER GRAHAM CHRISTIE, professor of mechanical engineering at Johns Hopkins University, Baltimore, Md., but more widely known throughout the world for his work in the design of power plants, who was nominated for the office of President of the Society, was born in Manchester, Ont., Canada, in 1880. He was graduated from the School of Practical Science, University of Toronto, in 1901 and received his M.E. degree from the same school in 1913.

Upon his graduation in 1901, Professor Christie started his engineering career as a mechanic in the East Pittsburgh, Pa., plant of the Westinghouse Machine Company, working his way up to the positions of erecting and test engineer and foreman, where he was able to do his part in the early development and construction of steam turbines and gas engines. After being in charge of the Westinghouse turbine and gas-engine exhibits at the World's Fair in St. Louis, Mo., in 1904, he resigned to become an instructor in mechanical engineering at Cornell University. However, he resigned again the following year in order to take charge of the erection, test, and operation of the first steam turbine built by the Allis-Chalmers Company, where he also did work on condensers, steam engines, gas engines, and pumps. In the fall of 1907, he became mechanical engineer in charge of construction and operation of the power plant of Western Canada Cement & Coal Company, Exshaw, Alberta, Canada.

But with his considerable experience in the design and construction of power-plant equipment and machinery, it was not long, 1909 to be exact, before Professor Christie was invited to become assistant professor of steam and gas engineering at the University of Wisconsin and later associate professor. In 1914, he joined the faculty of Johns Hopkins University as associate professor of mechanical engineering, being promoted in 1920 to a full professorship. Since 1916, he has been in charge of the evening engineering and technological school of the University.

In his connections with various engineering and manufacturing firms, he has worked on the design and construction of such power plants as Cahokia, Lake Shore and Avon Beach in Cleveland, Gould Street in Baltimore, Md., India Basin in San Francisco, Three Rivers in Quebec, Edmonton, Alberta, Can., Salt Creek in Wyoming, and also on power projects in Great Britain, Germany, Sweden, Switzerland, France, Denmark, Perak, Asia, Queensland, Australia, and Argentina, S. A. At the present time, he is consulting engineer to the Consolidated Gas, Electric Light & Power Co., Baltimore, Md., on designs of a new superimposed power plant.

Elected to membership in the A.S.M.E. in 1907, Professor Christie served as secretary-treasurer of the Baltimore Section for many years. Since 1918, he has been a member of various committees on Power Test Codes, being today vice-chairman of the Standing Committee on Power Test Codes. He has also given freely of his valuable time to the Society by serving on the Society's Committee on Publications, Nominating Committee, and Professional Conduct Committee; and as Manager for the years 1922 to 1925 and as Vice-President from 1925 to 1927.

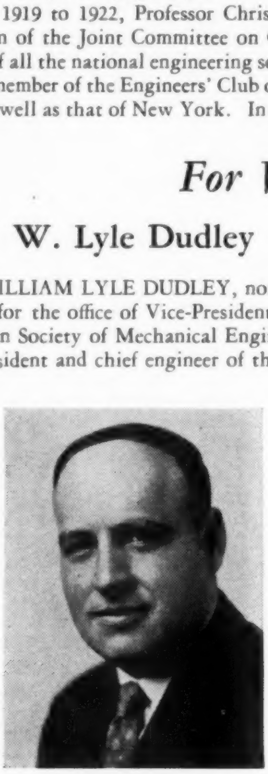
From 1919 to 1922, Professor Christie was chairman of the Joint Committee on Code of Ethics of all the national engineering societies. He is a member of the Engineers' Club of Baltimore as well as that of New York. In the last few years, Professor Christie has been or still is a member of the division of engineering, National Research Council; Prime Movers Committee, N.E.L.A.; American Advisory Committee, International Electrotechnical Commission; and the World Power Conference.

As an authority on steam turbines and power-plant equipment, Professor Christie has written many articles for technical journals, here and abroad. He is the author of the steam-turbine section of both Sterlings' "Marine Engineer's Handbook" and Kent's "Mechanical Engineer's Handbook."

For Vice-Presidents

W. Lyle Dudley

WILLIAM LYLE DUDLEY, nominated for the office of Vice-President of The American Society of Mechanical Engineers, is vice-president and chief engineer of the Western Blower Co., Seattle, Wash. Mr. Dudley was born in Portland, Ore., in 1894. He attended the University of Washington from which he was graduated in 1912 with the degree of B.S. in mechanical engineering. In 1926 he received the degree of M.E.



W. LYLE DUDLEY

Upon graduation he became associated as sales engineer with the Cromwell Manufacturing Co., with particular interest in the design of heating and ventilating installations. Two years later he resigned to enter the bridge-engineer's department of the County of King, Seattle, where his work dealt with bridge drafting and design. The following year he became engineer for the Western Blower Co. From 1915 to 1920 Mr. Dudley was in charge of all engineering work, which included the design, development, and installation of air-conveying, heating and ventilating, humidifying, and similar systems. Later he was made chief engineer of the company and then vice-president.

During the War, Mr. Dudley served in the U. S. Army, holding the rank of captain of infantry. He became a member of The American Society of Mechanical Engineers in 1921 and served on the Standing Committee on Local Sections, being chairman of it in 1935, and also as an advisory member of the Committee on Publications during the last two years. During the last year, he traveled hundreds of miles in his visits to Local Sections in Group VII of which he is Senior Councilor. He is also a member of the American Society of Heating and Ventilating Engineers and of the Society of American Military Engineers. He is responsible for promulgating the Engineers Registration Law for the State of Washington. Mr. Dudley is the author of a book on "Approach to Subatomic Physics," and of several technical papers. He was Manager of the Society from 1935–1938.

James W. Parker

JAMES WENTWORTH PARKER, nominated for Vice-President of The American Society of Mechanical Engineers, is vice-president and chief engineer of The Detroit Edison Company, and has his residence in Ann Arbor, Michigan. He was born in Auburn, New York, in 1886, of people who had lived in that state for a generation or more but had originally come from New England. His family moved to Kentucky when he was four years old and his boyhood was spent in Louisville.

He prepared for college in the Louisville Male High School and was graduated from Cornell University in 1908, with the degree of mechanical engineer. In 1935 he was awarded the honorary degree of master of science in mechanical engineering by the Detroit Institute of Technology. He is a member of the

J. W. PARKER

honorary societies of Sigma Xi and Tau Beta Pi.

After graduation from Cornell, Mr. Parker served an apprenticeship, first with the DeKalb Power & Light Company in Illinois, and then with the Vincennes Street Railway Company, Vincennes, Ind. In 1910 he moved to Detroit to become boiler-room engineer with The Detroit Edison Company, and has been employed continuously by that Company to the present time, with the exception of a year's leave of absence for war service in 1918.

In the course of this employment he has organized and directed the various engineering projects which his company has accomplished in the last twenty years, notably the design and construction of its electric power plants, Trenton Channel, Marysville, Delray No. 3, and Conners Creek. In addition to supervising new construction, Mr. Parker has also general responsibility for the operation of the Detroit Edison electrical system and of its generating plants, and central-heating plants and system.

During the World War he served in the Nitrate Division of the Ordnance Department, United States Army, as consulting mechanical engineer and head of that Division's inspection section.

He has served since 1929 as a Trustee of Cornell University, elected by the alumni and reelected in 1934.

Mr. Parker has been a member of The American Society of Mechanical Engineers since 1913. From 1928 to 1933 he served as member and Chairman of the Committee on Meetings and Program, and as Manager of the Society has been a member of its executive committee for the last two years.

He is the president of the Engineering Society of Detroit, having served on its board of directors since the organization of the new society in 1936, and is a member of the Michigan Engineering Society and the Prismatic Club of Detroit.

Alfred Iddles

ALFRED IDDLES, nominated for the office of Vice-President of The American Society of Mechanical Engineers, is a Fellow of the Society. He was born in Allegan Co., Mich., Dec. 1, 1889, and received his engineering education at Michigan State College where he received a degree of B.S. in mechanical engineering in 1912 and his M.E. degree in 1917. From 1912 to 1914 Mr. Iddles was foreman and then assistant superintendent of gas-manufacturing plants for the Michigan Light Company at Jackson and Flint, Mich. For the next three years he was instructor and then assistant professor of mechanical engineering at Michigan State College and, while teaching, engaged in consulting practice. During the War he served as captain in the chemical warfare service, being assigned to the poison-gas plant at Edgewood Arsenal, in charge of the public-utility service for this manufacturing plant. He was fuel engineer with the U. S. Bureau of Mines following the War and in 1920 became associated with Day & Zimmermann, Inc., in Philadelphia, as power engineer, and later as chief engineer. Later, he was vice-president and then executive vice-president of United Engineers & Constructors, Inc., with headquarters in Philadelphia.

Mr. Iddles is now associated with The Babcock & Wilcox Co. in their New York office and is charged with the supervision of the service department and the problem of correlating operating and test experience with design engineering.

Since his entrance into the Society in 1913 Mr. Iddles has served on many committees. During the years 1929 to 1933 he was a member of the executive committee of the A.S.M.E. Power Division, serving as its chairman in 1932 and was a Manager of the Society from 1934 to 1937. From 1931 to 1936 he was a member of the Standing Committee on Standardization, and is now the A.S.M.E. representative on the Council of the American Standards Association. He represents the Society on the Sectional Committee on Pressure Piping and is chairman of the subcommittee on Power Piping. Mr. Iddles is also a member of the Sectional Committee on Drawing and Drafting-Room Practice.

ALFRED IDDLES

He is coauthor of a textbook, "Steam Engine Design," and the author of many papers appearing in technical periodicals.

H. H. Snelling

HENRY HORNOR SNELLING, nominated for the office of Vice-President of The American Society of Mechanical Engineers for a one-year term, was born June 23, 1882, in Washington, D. C., and attended Central High School, in that city. After working as a draftsman for eight years, he entered George Washington University in 1907, being graduated with distinction, receiving his B.S. in mechanical engineering in 1913. He later attended Georgetown University, obtaining the postgraduate law degrees of LL.M. and M.P.L. in 1920. Mr. Snelling served through the various grades of the examining corps of the U. S. Patent Office to second assistant from 1912 to 1917. He has been engaged in the practice of engineering in the patent-law field since 1918, first as engineering expert with Church & Church and then as associate member of the firm, until 1922, at which time, he established his own offices in Washington, D. C., under the firm name of Snelling & Hendricks.

H. H. SNELLING

He was elected a member of the A.S.M.E. in 1919 and has been active in Society affairs since his admission, both locally and nationally. Appointed to the Committee on Constitution and By-Laws in 1930 on the recommendation of Past-President W. L. Abbott, Mr. Snelling became the chairman of that Committee in 1934 and at the request of two presidents continued in office for two additional years, to December, 1937, in order to complete the extensive revision of the Constitution, By-Laws, and Rules of the Society, as approved May 17, 1937.

In addition to his engineering connections, Mr. Snelling is active in legal, fraternal, and civic circles, being a member of the American Bar Association, the American Patent Law Association, a delegate to his county federation (Montgomery Co., Md.), and a past-president of his civic group.

For Managers

Clarke Freeman

CLARKE FARWELL FREEMAN, nominated for Manager of The American Society of Mechanical Engineers, was born in Winchester, Mass., June 1, 1890, his father being John Ripley Freeman, president of the Society in 1905. After receiving his A.B. degree from Harvard University in 1912, he completed a year of graduate work at Lawrence Scientific School.

In 1913, he started his engineering career as an industrial engineer with the Remington Typewriter Company where he installed the Gantt system of scientific management. After two years there, he left to become plant engineer of the Boston Insulated Wire and Cable Company. In 1916 he became connected as mechanical engineer with the Allied Machinery Company, in charge of machine tools on war contracts, and later was sent to France to set up machines and instruct the workmen in their operation. With the entrance of the United States into the war, he became an

engineer in the Ordnance Department, when his duties concerned the adapting of English and French war pieces to the use of the American Army, with particular reference to fuses, grenades, trench mortars, and other material. From July, 1918, he was responsible for the maintenance and supply of all small arms and trench-mortar ammunition for the First Army, A.E.F.

Upon his return to this country after the War, he returned to his position as mechanical engineer with the Allied Machinery Company. Then in 1921, he became a field engineer for the Manufacturers Mutual Fire Insurance Company, and in 1932 was appointed senior vice-president and engineer of the company, and its associated companies, The Rhode Island Mutual Fire Insurance Co., State Mutual Fire Insurance Co., Mechanics Mutual Fire Insurance Co., Enterprise Mutual Fire Insurance Co., and The American Mutual Fire Co., the position which he now holds.

CLARKE FREEMAN

He became a member of the Society in 1915 and since has been most active, not only within his own local section, but also in committee work of the Society at large. Today he is chairman of the Meetings and Program Committee to which he was appointed in 1933. Mr. Freeman acted as editor of the recent American translation from the German of Armin Schoklitsch's "Hydraulic Structures." In 1936, he served as president of the Providence Engineering Society.

W. H. Winterrowd

WILLIAM HOLLAND WINTERROWD, nominated for Manager of The American Society of Mechanical Engineers, was born on April 2, 1884, in the town of Hope, Ind. After finishing the grade and high schools in Shelbyville, Ind., he went to Purdue University from which he was graduated in 1907 with the degree of B.S. in M.E. In 1936, his Alma Mater honored him with a doctorate in engineering.

While in college, he spent his summers working as a locomotive wiper, blacksmith helper, and repairman on various railroads. Upon graduation, he became a special apprentice with the L.S.&M.S.R.R. (now the New York Central), and then enginehouse foreman. In 1910, after a short period as roundhouse foreman, Dr. Winterrowd was made assistant to the mechanical engineer of the railroad. In 1912, he left to become mechanical engineer of the Canadian Pacific R.R. in Montreal.

In 1917, after converting part of the railroad's largest shop into a munitions plant, he was selected as a member of Lord Milner's Mission to Russia. There he traversed every mile of railway in European Russia, studying motive power, cars, shops, enginehouses, and machine-tool equipment. His report was made directly to David Lloyd George, prime minister of England at the time. Upon his return to Montreal in 1918, he was made chief mechanical engineer of the Canadian Pacific R.R. Then from 1923 to 1927 he was assistant to the president of the Lima Locomotive Works and then from 1927 to 1934 vice-president of the company. In 1934, he became vice-president of the Franklin Railway Supply Co., Inc., with offices in Chicago.

Dr. Winterrowd joined the Society in 1907 as a junior member. He has been a member and chairman of the Committee on Publications, as well as of the Railroad Division and its Executive Committee, a member of committees on Policies and Budget, Biographies, Junior Participation, and Citizenship Manual. He has served on the executive committees of both the Metropolitan and Chicago Sections.

W. H. WINTERROWD

Many technical articles and papers by Doctor Winterrowd on railway mechanical engineering have been published. He is a director of the Purdue Research Foundation, a member of the Canadian Railway Club, American Railway Association, Western Railway Club, American Railway Engineering Association, International Fuel Association, The Newcomen Society, The Royal Astronomical Society of Canada, and many other organizations.

W. R. Woolrich

WILLIS RAYMOND WOOLRICH, nominated for Manager of The American Society of Mechanical Engineers, was born on March 1, 1889, in Mineral Point, Wis. While in high school and after, he had already launched his engineering career by working for the local electric company before school hours and later by performing duties from fireman to mill mechanic in a zinc-concentrating mill. However, shall we say fortunately, the depression of 1907 closed the mill and the eighteen-year old boy was on his way to Madison, Wis., to take an engineering course at the University of Wisconsin. Dean Woolrich was granted a degree of B.S. in E.E. in 1911, but because most of his work in industry in later years was along the lines of mechanical engineering, it was most fitting that his Alma Mater should give him an M.E. degree in 1923.

Upon graduation, the young Woolrich spent some time with the Commonwealth Edison Co. of Chicago and with the Union Switch and Signal Company of Swissvale, Pa. In 1911, he went back to Chicago to teach engineering at DePaul University, but after a year, left to take a training course with the Western Electric Company. After becoming assistant methods engineer, International Harvester Co. borrowed him so that he could institute a training course there similar to the one used at Western Electric. This course, which contained many of his own ideas, was so successful that he was invited to join the faculty of the University of Tennessee as an assistant professor of mechanical engineering.

After doing his bit during the World War, Dean Woolrich returned to the University where he eventually became head of his department. When the Tennessee Valley Authority was established in 1933, he was one of the first engineers selected to help develop this vast enterprise. In 1934, he was made a director and headed the agricultural-industries division until 1936 when he was called to the University of Texas to become dean of the college of engineering.

W. R. WOOLRICH

He joined the A.S.M.E. in 1919 and served as secretary and then chairman of the Knoxville section. His abilities were soon recognized and as a result he is chairman of the Committee on Local Sections, and has been a member of the Nominating Committee, Special Research Committee on Mechanical Processing of Cottonseed, and the Process Industries Division. As chairman of the Committee on Local Sections, he has been an advisory member of the Executive Committee of Council during the past two years.

Dean Woolrich has written many articles for technical magazines and several books, one of these being the Handbook of Refrigerating Engineering. He is a member of the A.S.R.E., S.P.E.E., Newcomen Society, Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, Pi Tau Sigma, and Sigma Xi.

Program for A.S.M.E. Wood Industries Division Meeting, High Point, N. C.

Two-Day Meeting, Sept. 22–23, to Cover Economics and Waste, Machinery, Glue, Plywood

THE WOOD Industries Division of the A.S.M.E. has arranged a national meeting to be held in late September at High Point, N. C., in cooperation with the Southern Furniture Manufacturers' Association. The latter group will hold its meeting on Wednesday, September 21, and the meetings of the Wood Industries Division will occur on September 22 and 23. Members of both organizations are invited and urged to attend all the sessions covering the three-day period.

The tentative program for the A.S.M.E. Wood Industries Division follows:

Economics and Waste

Thursday Morning

Obsolescence in Woodworking Machinery, by Paul T. Norton, Jr.

The Utilization of Wood Waste, by H. M. Sutton

The Place of the Engineer in Cost Accounting, by C. F. Scribner

Utilization of Wood Waste in Europe, L. M. C. Wegner

Training Men for the Wood Industries, by H. L. Henderson

Manufacturing Installation Material From a Former Forest Waste, by W. W. Williams

Banquet

Thursday Evening

Industrial Development in North Carolina, by C. R. Hoey, Governor of North Carolina

The History of Woodworking Hand Tools, by James H. Herron

Machinery

Friday Morning

Experiments in Wood Planing, by E. M. Davis

Investigations in Wood Drilling, by G. E. French

Notes on the Elastic Theory of Wood Failure, by C. B. Norris

Glue-Plywood

Friday Evening

Urea-Formaldehyde Resin-Glue Development, by W. F. Leicester

Liquid Resin as a Plywood Adhesive, by K. J. Kopplin

Serviceability of Resin Glue Joints, by Don Brouse

Excursions

In addition to the technical sessions there will be visits arranged to a half dozen plants located at High Point or in the vicinity. These include the plants of the B. F. Huntley Furniture Company, Winston Salem, N. C., Marietta Paint & Varnish Co., High Point, N. C.; Statesville Plywood & Veneer Co., Statesville, N. C., Myrtle Desk Co., and The Tomlinson Plant, both of High Point, N. C., and the Thomasville Chair Company, Thomasville, N. C.

The Sheraton Hotel at High Point has been selected as headquarters and all technical sessions will be held there. All members of the Society interested in attending this meeting are urged to write directly to the Hotel and make room reservations, and this should be done at as early a date as possible. High Point is reached by the Southern Railroad and train No. 33 which leaves Boston at 3:00 p.m., New York 9:45 p.m. and Washington at 3:00 a.m. arrives at High Point at 10:07 a.m. The early train no. 39 leaves Boston at 11:00 a.m., New York at 6:30 p.m., and Washington at 10:35 p.m. This arrives at High Point at 6:28 a.m. Coming north train no. 40 leaves High Point at 11:10 p.m. and arrives at Washington 7:10 a.m., at New York at 11:30 a.m., and Boston at 5:25 p.m. It should be noted that these tables are the current ones and are subject to change by the date of the meeting on September 20, and so should be checked.

HEADQUARTERS FOR MEETING

Proposed Amendment to A.S.M.E Rules

PROPOSED changes in the A.S.M.E. Rules relating to fees and dues, as adopted by the Council at the 1938 Semi-Annual Meeting of the Society at St. Louis, follow:

Article R5, Fees and Dues

Rule 1 A Student-member recommended by the Honorary Chairman of his Student Branch may be elected by the Council to Junior membership, the election being subject to his graduation. The payment of dues as a Junior Member for one year at any time prior to September 30 of the calendar year following the calendar year in which he graduates, shall constitute acceptance of election and shall give him all the rights and privileges of the Junior Member grade from the date of such payment to September 30 of the calendar year following the calendar year in which he graduated.

Rule 2 The Student-member may pay an initial quarter-year's dues, $2.50, to indicate acceptance of election. If he chooses this method, the remaining three quarter's of the dues, $7.50, shall be due not later than the first of the month following a three months' period thereafter. If he does not accept or follow this procedure and complete his payments before September 30 of the calendar year following the calendar year in which he graduated, the automatic scheme of transfer without initiation fee expires and thereafter he must make a new application for Junior membership and if elected pay an initiation fee of $10.

A.S.M.E. to Hold Session With American Welding Society, Detroit, Oct. 18

THE A.S.M.E. has received invitations from the American Society for Metals and the American Welding Society to cooperate in the Metals Congress to be held at Detroit the week of October 17, with headquarters at the Book Cadillac Hotel. For the past few years the Society has cooperated in this meeting and this year the Detroit Section will schedule its initial meeting of the year at the same time so as to give a full day to A.S.M.E. activities.

The program which follows is particularly recommended to the members of the Iron and Steel, Machine Shop Practice, Power, and Process Industries Divisions.

Further details concerning the program will be published in the September issue.

Tuesday Morning

Chairman: A. E. White

Vice-Chairman: C. W. Obert

Welding of Ammonia Containers, by E. H. Behling

Brazing Tubes in High-Pressure Boilers With Silver Alloys, by A. W. Weir and H. M. Webber

Welding Bronze and Nonferrous Alloy Piping, by H. D. Lanterman

Effect of Different Preheating and Annealing Temperatures on Welded Carbon Molybdenum Piping, by R. W. Clark

Afternoon and Evening

Sponsored by the Detroit Section

Trip to a steel plant

Detroit Section Dinner Meeting with paper on Blast-Furnace Design

Power Show, New York, Dec. 5–10

DURING the week of the Annual Meeting of the A.S.M.E. in New York, Dec. 5–10, the 13th National Exposition of Power and Mechanical Eegineering will be held at Grand Central Palace when manufactures will display their latest products to the visiting engineers.

American Engineering Council

Presents

The News From Washington and Elsewhere

Work-Relief Projects

ANTICIPATING the inauguration of another program of federal spending for relief purposes, and in the absence of a national inventory of public-works deficiencies, the staff of the American Engineering Council has queried engineer and administrative executives of the principal agencies of the government, administering the use of emergency funds, for factual information regarding the exploitation by public bodies of public-works possibilities.

None of the findings are official, but it seems as if those who must develop work-relief projects might render greater service to the communities, as a whole, by concentrating on sewage treatment and disposal plants, water purification and supply facilities, elimination of grade crossings, slum-clearance work, and urban mass-transportation facilities and other long-term projects, including waterfront improvements and the consolidation of freight and passenger terminals.

Fees on Housing Projects

Staff investigation of an early report that the United States Housing Authority wanted to reduce drastically the scale of fees to be paid by local housing authorities revealed the fact that U.S.H.A. officials were actually in favor of increasing architects' fees and anxious to see engineers properly compensated for the work they might do on housing construction for slum-clearance purposes. The staffs of both A.E.C. and the American Institute of Architects have busied themselves with the promotion of a better scale of fees.

Executive Committee of A.E.C. Meets

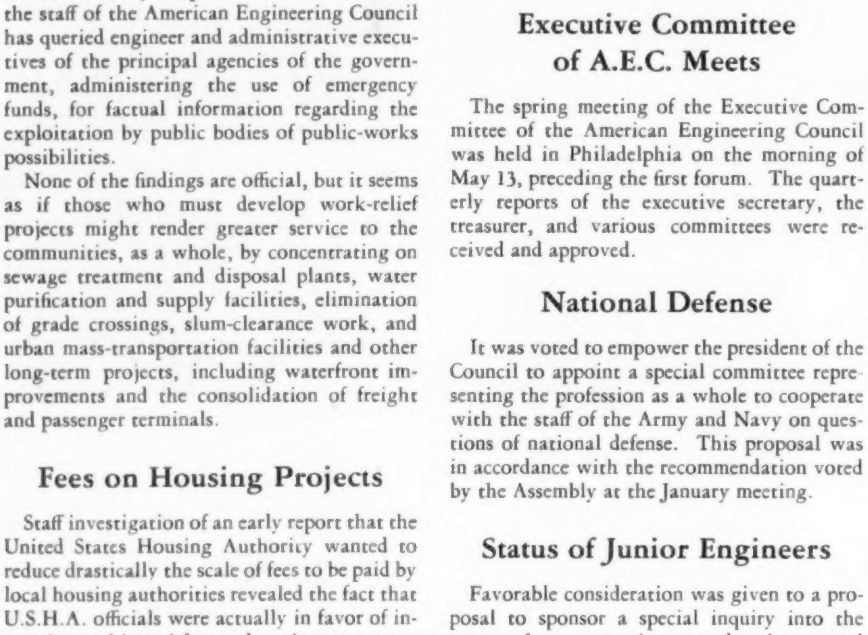
The spring meeting of the Executive Committee of the American Engineering Council was held in Philadelphia on the morning of May 13, preceding the first forum. The quarterly reports of the executive secretary, the treasurer, and various committees were received and approved.

National Defense

It was voted to empower the president of the Council to appoint a special committee representing the profession as a whole to cooperate with the staff of the Army and Navy on questions of national defense. This proposal was in accordance with the recommendation voted by the Assembly at the January meeting.

Status of Junior Engineers

Favorable consideration was given to a proposal to sponsor a special inquiry into the status of young engineers under the general direction of the A.E.C. Engineering and Allied Technical Societies Committee on Engineers' Economic Status, of which Prof. J. S. Dodds is chairman, the work to be conducted by the Personnel Research Federation with funds supplied by The Engineering Foundation.



Courtesy American Airlines, Inc.

AERIAL VIEW OF PROVIDENCE, R. I.

(A.S.M.E. Fall Meeting in Providence, Oct. 5–7. See page 640 of this issue.)

A.E.C. Has 52 Members

The executive secretary announced the election of the Engineers' Club of Memphis and the Structural Engineers' Association of California as members of the American Engineering Council, bringing the total members of Council up to 52, the largest in its history.

Public-Forum Plans

The executive committee received many expressions of approval of the proposed series of public forums to be conducted by the Council. Consideration was given to several suggestions for extending and developing the forum idea. The Public Affairs Committee, under whose auspices the forums are being directed, will be particularly glad to receive suggestions and subjects for future forums.

F.H.A. Aid to Engineers

Rehabilitation of hundreds of partially blighted residential neighborhoods has been one of the direct results of the subdivision review work of the F.H.A. Land Planning Section. Since this phase of housing always involves engineering, it is suggested that interested engineers communicate with Seward H. Mott, chief of the Land Planning Section of the Federal Housing Administration, 1001 Vermont Avenue, N. W., Washington, D. C.

55 Per Cent Fuel Savings Made Since War

Two major causes, fuel-saving devices and the substitution of other fuels which require less labor in their production, have reduced the demand for coal and brought increasing unemployment in the coal fields during the last two decades, according to a report of the National Research Project of the Works Progress Administration made public on June 12 by Administrator Harry L. Hopkins. It is Report No. E-5 of the series on "Mineral Technology and Output per Man Studies" and may be obtained by writing to Publications Section, Division of Information, Works Progress Administration, Washington, D. C.

Educational Orders

Approved by the President on June 16, the so-called Educational Orders Bill fills a long-felt want in the country's national defense structure. The new law authorizes the Secretary of War to place educational orders for war materials of special or technical design to allow American producers to familiarize themselves with such production. Bids are to be solicited only from concerns which the Secretary may judge to be competent to manufacture for the government in war time. Contracts must have the approval of the President.

(*A.S.M.E News continued on page 656*)

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 27, graduate, married. Three years' operating, testing, and maintenance experience in industrial power plants; $1^1/_2$ years as plant engineer in large institutional heating plant. Available as instructor or assistant professor. Me-109.

MECHANICAL ENGINEER, graduate, 1937. Eleven months' drafting and design with boiler manufacturer; excellent educational record; moderate salary with future. Me-110.

MECHANICAL ENGINEER, 29, graduate M.E.; production experience specifying manufacturing procedures, purchasing or designing special machinery, estimating and controlling costs, installing production and time-study systems. Also general construction work. Me-111.

MECHANICAL ENGINEER, honor graduate University of Florida, 1938; 22; single. Will start from bottom. Location preferred, East. Me-112.

MECHANICAL ENGINEER with broad practical experience in machine design and production, power plants, industrial and chemical plant, layouts and designs, piping, special equipment, etc.; also valuable executive and business practice. Me-113.

MECHANICAL ENGINEER, 26, graduate University of Michigan; desires position leading to sales with company marketing engineering materials, processes or equipment; 2 years' experience production supervision, 2 years' drafting and design. Me-114.

MANUFACTURING EXECUTIVE, 43, offers 25 years of diversified and practical industrial experience. Familiar with every mechanical manufacturing and controlling function including direction of tooling, maintenance, personnel, costs, and general plant management. Me-115.

SALES ENGINEERING position desired by mechanical engineer with 8 years' experience in refrigeration, purchasing, and inspection. Now employed as chief inspector for portable-tool manufacturer. Good knowledge machinery and production. Me-116.

ENGINEER, M.S. in M.E., desires position as instructor or tool and equipment designer in tube, rod, or sheet mill. Experience in power-plant operation, drafting, and machine design; copper and brass industry. Me-117.

AERONAUTICAL ENGINEER, 23, recent graduate New York University; honor student with scholastic record over 90 per cent; 6 months' drafting experience and 5 months' clerical experience. Me-118.

INDUSTRIAL ENGINEER, now employed; experienced in supervising time study and standards department, installing bonus plans, planning and scheduling, costs, plant layout, and teaching. Author of technical papers. Desires teaching or change. Me-119.

EXECUTIVE ENGINEER, 44. Technically trained with broad experience in chemical and allied industries including plant management, production control, process development, student training, maintenance, power, design, and construction. Exceptional record. Me-120.

PLANT MANAGER OR MANUFACTURING EXECUTIVE with excellent record for efficiency, cost reduction, and industrial relations; wishes connection with firm using castings as base product, desiring reorganization or development of manufacturing. Me-121.

JUNIOR M.E., graduate Alabama Polytechnic Institute, 1936. Experienced in architectural detailing, also construction and design of utilities, bridges, roads; has handled 100 men on construction jobs. Will travel. Me-122.

MECHANICAL ENGINEERING GRADUATE of class of '38, graduate of N. C. State, elongation 5 feet 8; 160 is his weight, for information please investigate. Me-123.

MECHANICAL ENGINEER, 38. Fourteen years' experience in drafting, design, plant maintenance and construction, and management, principally in chemical industry; registered professional engineer, West Virginia; desires position preferably in Middle West. Me-124.

MECHANICAL ENGINEER; 14 years' plant engineer in charge of buildings, power plant, installation and maintenance of equipment large industrial plant now closed; 7 years' design, installation and selling mechanical stokers. Me-125.

MECHANICAL ENGINEER, recent Stevens graduate. Excellent character and personality. Prefers work in sales engineering or production. Me-126.

POSITION WANTED by graduate engineer, 36, now in responsible position in sales department of plastic-molding firm. Wide experience in molding, mechanical, electrical fields. Creative and organizing ability. Me-127.

YOUNG MECHANICAL ENGINEER, M.S. degree 1938, chemical-engineering training, desires plant position in eastern U. S. in chemical industry. Specialized in corrosion, process design, equipment selection. Me-128.

COLLEGE TEACHING OR ASSOCIATION SECRETARY, 46. Railroad, business-paper editor, sales and teaching experience. B.S. and M.E. degrees. Committee member and active Society affairs many years. Fine record accomplishment. Endeavoring to change fields. Me-129.

MECHANICAL ENGINEER; 26; single; M.E. Stevens Institute, 1933; 5 years field and office experience in Geodetic Survey work (levels, angles, and computation). Mathematical and statistical work regardless of complexity. Me-130.

POSITIONS AVAILABLE

SUPERINTENDENT to take charge of printing and bookbinding plant. Must have several years' experience in similar position. Salary, \$3600–\$4500 a year. Apply by letter. Location, Ohio. Y-3048-C.

SALES-PROMOTION ENGINEERS, ages about 35. Must be thoroughly acquainted with all phases of steel manufacture and its use; also good sales-promotion men, familiar with the manufacture of steel. Latter, however, must have good personalities and commercial sense. Salary commensurate with ability. Apply by letter. Location, foreign. Y-3049.

DRAFTSMAN with experience in kitchen equipment layout for cafeterias. Apply by letter. Location, New York, N. Y. Y-3053.

FOUNDRY SUPERINTENDENT, graduate mechanical engineer, 35–45, who understands equipment and maintenance. Must be able to plan future improvements and to assume responsibility for quality of metal. Must know metal mixtures, etc. Apply by letter. Location, New York, N. Y. Y-3056.

FUEL ENGINEER, about 30, graduate mechanical engineer to take charge of a small steam-power plant. Work will be to test and purchase coal, increase efficiency, make heat balances, etc. Salary to start, \$3000 a year. Traveling. Apply by letter. Location, South. Y-3067.

DESIGNER, mechanical engineer to design and develop typewriters. Must have executive ability. Experience in design of typewriters is essential. Apply by letter. Location, New York, N. Y. Y-3068.

(*Continued on page 658*)

Teaching Opportunities for M.E. Graduates

COMPETENT apprentice and vocational-school instructors in the machinery field are of the greatest importance to industry, according to an article in the June, 1938, issue of *Machinery*. The various state education departments are providing for the necessary teacher training of men qualified for teaching in trade schools.

In New York State, the Industrial Teacher Training Department is located at 80 Center Street, New York City. Most of the other states maintain similar training services, information relating to which may be obtained by addressing the State Education Department of the various states.

The opportunities for advancement in this field of teaching are attractive to competent men. The salaries of trade-school teachers, like wages in industry, vary with the sections of the country. For example, the salary of the vocational trade teacher in Pittsburgh starts at \$1800 a year and advances to \$3200 a year. In Chicago, the starting salary is \$1800, advancing in ten years to \$3800. In New York, the trade teacher usually starts at \$9 a day, while serving on a permanent-substitute license. When he obtains a regular appointment, he starts at \$2140 annually, with increases of \$150 a year until an annual salary of \$4500 is reached.

[1] All men listed hold some form of A.S.M.E. membership.

GRADUATE MECHANICAL ENGINEER, young, who would like to develop along operating lines. Must have actual experience in cement-plant design and operation. Apply by letter. Location, New York, N. Y. Y-3073.

GRADUATE ENGINEER, 35–40, with successful record in direct supervision of skilled and unskilled labor. Must have ability to analyze, organize, and systematize various processes. Should have exceptionally good personality, and background of building maintenance. Salary, $5000 a year. Apply by letter. Location, New York, N. Y. Y-3081.

DRAFTSMAN, 30–40, for layout work on typewriters and calculating machines. Must have experience in dimensioning and establishing tolerances. Apply by letter. Location, Connecticut. Y-3082.

CHIEF ENGINEER, graduate mechanical engineer thoroughly versed in theory. Must be capable of handling job of chief engineer and master mechanic for large industrial company, and able to assist in work of consulting nature when necessary. Should have experience in tool and machine design, particularly products engineering. Familiarity with steel fabrication would be helpful. Will be responsible for supervising plant engineering and maintenance of equipment. Salary, $5000 a year. Apply by letter. Headquarters, Middle West. Y-3084C.

MECHANICAL ENGINEER, 35–50, to take charge of all mechanical work including maintenance, power plant, etc. Must have chemical-plant experience. Salary, $2500–$3000 a year. Apply by letter. Location, New York Metropolitan area. Y-3094.

INSTRUCTOR for mechanics department of school of mechanical engineering. Must have advanced training beyond undergraduate level in theoretical or fluid mechanics or both. Master's degree desirable, but not essential. Teaching experience not necessary. Time available for graduate study. Salary, $1800 for school year. Apply by letter giving full college and experience record and enclosing recent snapshot. Location, New York State. Y-3098.

STEAM-TURBINE ENGINEER with experience in thermodynamic and mechanical design of turbines up to at least 5000-kw and with modern steam pressures and temperatures. Opportunity. Apply by letter. Location, New York State. Y-3099.

SALES ENGINEER, 30–35, with machine-tool experience. Will be given Connecticut territory, and only resident of Connecticut will be considered. Apply by letter. Y-3101.

SENIOR ENGINEERS with oil-field or refinery experience. Must be fully qualified and suitable for administrative positions. Apply by letter in duplicate giving full details of qualifications, experience, personal data, education, salary expected, references, etc. Location, foreign. Y-3103.

DESIGNER on gadgets, intricate mechanisms, etc. Must have at least ten years' experience along these lines. Apply by letter. Location, New York, N. Y. Y-3120.

SALES ENGINEER, 35–40, graduate mechanical or civil engineer with experience in selling heavy machinery in contracting field in metropolitan areas. Only an engineer with this experience will be considered. Apply by letter. Location, New York Metropolitan area. Y-3124.

ASSOCIATION SECRETARY, 35–40. Must have good personality and technical education. Apply by letter. Location, Middle West. Y-3125C.

GRADUATE MECHANICAL ENGINEER, about five years out of college with knowledge of electrical engineering and experience in heating, ventilating, and power-plant work. Salary, $175–$200 a month to start. Apply by letter. Location, New England. Y-3129.

SALES ENGINEER, 30–40, with experience in steam equipment in New York Metropolitan district. Must also have power-plant contacts. Apply by letter. Location, N. Y. C. Y-3130.

SALES ENGINEER, 25–35, to sell steam equipment to marine trade. Must be acquainted and have contacts with marine builders and shippers. Traveling. Apply by letter. Headquarters, East. Y-3131.

FOREMAN for machine and die shop. Must have record of accomplishment in developing and building automatic machinery and dies, and should preferably have experience in stamping and forming lithographed tin plate, as for caps and cans, and in building sealing machines. Apply by letter giving personal data, experience, salary expected, and enclosing recent photograph. Y-3133.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after August 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

BOOTH, J. W., Vancouver, B. C.
BRAGG, FRANCIS COOLIDGE, Bristol, R. I.
COWAN, EDWARD L., Bogalusa, La.
CRAIG, B. M., Pasadena, Calif.
DAUM, JOHN H., Cincinnati, Ohio
FLYNN, E. D., Oakland, Calif.
GAMBERTON, JAMES H., New York, N. Y.
GARLAND, CLYNE F., Berkeley, Calif. (Rt)
GRAESSER, C. H., Bridgeport, Conn.
HIEBER, GEORGE E., Cincinnati, Ohio
HOOTS, PAUL F., New Orleans, La.
HUNT, MELVIN W., Midland, Mich.
KISNER, ALBERT G., Philadelphia, Pa.
LEESE, ROBERT, Philadelphia, Pa.
MARTIN, JOHN GREGORY, Cincinnati, Ohio
MCGIRR, ROBERT, New York, N. Y.
MINOR, JOHN C., New York, N. Y.
NAGEL, E. W., Ferguson, Mo.
NARAYANAN, S., Madras, South India
NEAR, LLOYD B., La Crescenta, Calif.
NIELSEN, MORRIS, New York, N. Y.
ROBERTSON, STEWART F., Baltimore, Md.
SCHILLING, ROY C., Wilmington, Del. (Rt)
SMITH, RUSSELL J., Milwaukee, Wis. (Rt & T)
VAN DENBURG, J. W., New York, N. Y.
WHARTON, H. JEROME, Maracaibo, Venezuela
WHITTAKER, ALBERT E., Boston, Mass. (Rt)
WOOD, WALLACE DEAN, Rochester, N. Y.

APPLICATIONS FOR CHANGE OF GRADING

Transfers to Member

EVANS, N. A., New York, N. Y.
GLOVER, J. B., Marietta, Ga.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

DUDA, OSWALD, June 2, 1938
EARLL, CHARLES I., June, 1938
HAMERSLEY, CARL S., June 6, 1938
KELLER, WALTER D., May 23, 1938
MCPARTLAND, MICHAEL, June 10, 1938
OSWALD, JOHN CLYDE, June 22, 1938
PARK, FRANKLIN A., June 17, 1938
RIVETT, EDWARD, December 16, 1937
THOMAS, CARL C., June 5, 1938

A.S.M.E. Transactions for July, 1938

THE July, 1938, issue of the Transactions of the A.S.M.E., contains the following papers:

Tests of a 7 by $10^1/_2$-In. Bearing at 3600 Rpm (RP-60-8), by L. M. Tichvinsky

Investigation of Stress Conditions in a Full-Size Welded Branch Connection (FSP-60-12), by F. L. Everett and Arthur McCutchan

Power Panel Discussion on New High-Temperature High-Pressure Stations (FSP-60-13), Papers by J. A. Keeth, A. E. Grunert, D. S. Brown, Louis Elliott, J. N. Landis, J. F. Muir, Philip Sporn, W. E. Caldwell, C. H. Spiehler, and J. A. Reich

DISCUSSION

On previously published papers by Messrs. A. J. Büchi; J. F. Barkley, and Lybrand P. Smith

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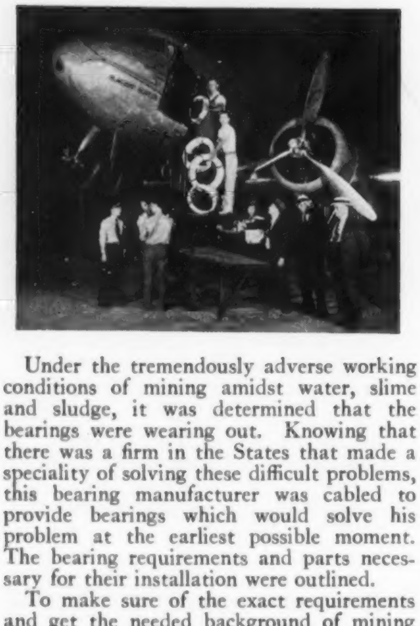
• NEW EQUIPMENT

Record Transpacific Air Express Shipment

Probably the highest charge ever made for an Air Express shipment, amounting to $2500.00, has just been paid to cover the shipment of two Bantam Roller Bearings from South Bend all the way to Manila, Philippine Islands by air. Leaving South Bend Monday night via American Airlines, they were transferred to a United Airline plane at Chicago for San Francisco. On Wednesday they leave by Pan-American Transpacific Clipper for Manila.

The Air Express charge for this shipment amounts to approximately three times the cost of the bearings. This is small, however, compared to a possible loss of $7500.00 each day should a crippled dredge used for digging gold from sixty-five feet beneath a river bed completely break down.



Under the tremendously adverse working conditions of mining amidst water, slime and sludge, it was determined that the bearings were wearing out. Knowing that there was a firm in the States that made a speciality of solving these difficult problems, this bearing manufacturer was cabled to provide bearings which would solve his problem at the earliest possible moment. The bearing requirements and parts necessary for their installation were outlined.

To make sure of the exact requirements and get the needed background of mining conditions, A. H. Frauenthal, General Manager of the Bantam Bearings Corp., South Bend, Ind., arranged to talk by Long Distance to the engineer in charge at Manila ten thousand miles away. In nine minutes of remarkably clear conversation, all details were made clear so that successful compliance with the order was assured.

Absolute accuracy was necessary since the nearest machine shop was a hundred miles away through the jungle. Everything must fit perfectly when delivered.

The bearings and parts which would ordinarily take a month to produce were made in nine days. Shipment, which would ordinarily take twenty-eight days by fastest boat, was cut down to five and a half by Clipper Ship—making a saving of twenty-two and a half days.

There are few occasions that would justify paying twenty-five hundred dollars for an Air Express shipment, but compared to a possible saving of one hundred and eighty-five thousand dollars which might be lost through idleness, the cost is small.

This unique service from America to the Orient is a striking example of how American inventions are helping to develop world resources and bring the far places of the world closer together. The combined resources of Cable, Long Distance Phone, Air Express, Transpacific Clipper and alert manufacturing were necessary to bring about this unusual service.

Jenkins Patented U-Bolt Valve

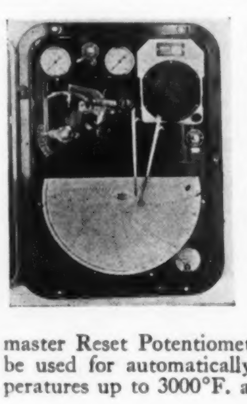
Jenkins Bros., 80 White Street, New York, N. Y., has just announced new Bronze Mounted and All-Iron U-Bolt Gate Valves. They are the result of a definite effort to improve the design and construction of this type of valve, which has wide popularity where a husky, general utility valve is desired. This type of valve combines exceptionally quick, easy disassembly for inspection or repair, with high resistance to springing and distortion.

Jenkins claims that their new patented valve not only possesses all standard features of merit, but also many features offered by no other valve on the market. One of the unique advantages is a renewable "Bonnet-Saver-Bushing." This makes it unnecessary to junk the valve bonnet when operating threads are worn. By slipping a new "Bonnet-Saver-Bushing" into position, the user obtains good as new thread engagement in the same old bonnet. Another advantage claimed is that because this unique bushing can be lifted out, the user can get into the upper part of the bonnet chamber to do a thorough job of cleaning out any deposits that form there.

The illustrated folder which gives unusually clear and complete details about the new Jenkins U-Bolt Valve also stresses the "Heavy-Duty" Body and Bonnet employed, claiming that they will not break even if the nuts on the U-bolt are tightened to an extreme that would cause the high tensile steel U-bolt to break. The folder—No. 179—gives list prices, sizes and ratings. A copy can be obtained by writing to Jenkins Bros. This new valve is priced the same as regular good valves of this type.

New Pneumatic Reset Potentiometer Controller

A new Reset Potentiometer Controller for continuous processes, combining Bristol's



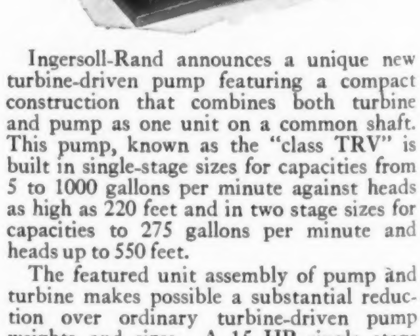
Pyromaster Potentiometer temperature measuring system and Bristol's Reset Free-Vane air-operated control mechanism, has just been announced by The Bristol Company, 21 Bridge Street, Waterbury, Conn. This instrument, known as Bristol's Pyromaster Reset Potentiometer Controller can be used for automatically controlling temperatures up to 3000°F. and is offered as a Pyrometer and also as a Resistance Thermometer. A record of the controlled temperature is made on a 12-inch circular chart.

The Pyromaster temperature measuring system is electrical, operating on the potentiometer principle. This system is widely used in other Bristol's temperature recording and controlling instruments. It has many exclusive advantages, such as the following: There is no mechanical motion of any kind except as required when the temperature changes (minimum wear)—It is never necessary to lubricate any part of the operating mechanism—The Galvanometer is completely enclosed in a case—It is unaffected by excessive vibration.

The Reset Control mechanism operates on the basic Free-Vane principle of air-operated control. This principle has been used by The Bristol Company for many years. As the name implies, there is no retarding action at any point on the scale. The measuring system is free to measure and record the true temperature above, below, and at the control point. This is possible, because due to the unique design employed, practically no power is required from the measuring element to operate the control apparatus.

In the Pyromaster Reset Potentiometer Controller certain features of field adjustability have been added, whereby the throttling range and rate of reset may be changed over a wide scope by the user through simple finger adjustments to suit the requirements of the process involved. The company's bulletin 507 describes this instrument.

New Turbine-Driven Pump



Ingersoll-Rand announces a unique new turbine-driven pump featuring a compact construction that combines both turbine and pump as one unit on a common shaft. This pump, known as the "class TRV" is built in single-stage sizes for capacities from 5 to 1000 gallons per minute against heads as high as 220 feet and in two stage sizes for capacities to 275 gallons per minute and heads up to 550 feet.

The featured unit assembly of pump and turbine makes possible a substantial reduction over ordinary turbine-driven pump weights and sizes. A 15 HP single stage unit is about 32" long and other sizes are proportionately small. This compactness of design not only reduces initial cost, but installation and upkeep expense as well. No special foundation is required and units are available for operation in any position. They may be bolted to the floor, wall, tank, column or ceiling, as is most convenient.

Continued on Page 1

Continued from page 12

Suitable for use wherever a turbine-driven pump is desirable and replacing many older duplex steam pumps, these units are particularly applicable for use in refineries, chemical plants, mines and other locations where hazardous gases are present. They are equally adaptable for general industrial service where process steam may be utilized, as well as for boiler feed service at boiler pressures up to 200 lbs. per sq. in. When steam is not available, the turbines can be efficiently operated on compressed air.

Additional information on these pumps is contained in bulletin 2390, copies of which may be obtained from the Ingersoll-Rand Company, 11 Broadway, New York, N. Y., or any of their branch offices.

245-Ton, 92-Foot Bubble Tower Shipped Nearly a Thousand Miles by Rail

The largest single piece of industrial equipment ever made in St. Louis—a steel tower 92 feet long, weighing 245 tons—has been completed at the Heine Boiler Division of the Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y., and has completed its 916-mile journey overland to Smith's Bluff, Texas, where it will be used in the Pure Oil Company refinery.

Equal in weight to about 170 popular priced automobiles which shipped assembled would require 34 freight cars, the tower was one of the heaviest and largest single pieces of freight ever shipped by rail. Special equipment in the form of 400,000-pound capacity freight cars with 16 wheels each was used to carry the load. There are only four such cars in use in the United States. Shipments were handled by the Frisco Railway to Neosho, Mo., and from there by the Kansas City Southern Railway direct to the refinery.

The tower was held on the cars by means of heavy oak timbers of such size that it was necessary to have them cut to order at a logging camp in Southeastern Missouri. These timbers were arranged on swivels to enable the shipment to go around curves. At a number of railroad bridges and tunnels the tower almost scraped the sides since its diameter at the widest part is 13 feet 2 inches.

Firebox quality steel plate nearly $2^1/_2$ inches thick was used in constructing the tower and all seams were welded by the electric fusion process. The welding, which totaled about 500 linear feet, was tested by X-Ray powerful enough to penetrate the steel to insure against defects and the tower was tested under 630 pounds of water pressure per square inch. To relieve any strains in the metal which might have been set up in fabrication, the entire tower was heated to a uniform temperature of 1150 degrees for four hours, then allowed to cool slowly.

Known as a bubble tower, the vessel has on the inside a series of perforated steel trays with risers and caps through which oil vapors will be allowed to rise counter-current to liquid overflow. At certain levels in the tower different types of petroleum products will be obtained from the rectification process.

A number of other refinery vessels to be used at the same plant were shipped recently by the Heine shop. These included a crude oil tower, nearly 99 feet long and weighing about 133 tons, and two identical evaporation towers 42 feet long, each weighing about 110 tons. This equipment was built to the design and on the order of the Lummus Company of New York, engineers and contractors for this installation, as part of a 22,000-barrel modern combination selective cracking unit which the Lummus Company is building and erecting for the Pure Oil Company at Smith's Bluff.

The Pure Oil Company operates seven modern refineries. The huge Smith's Bluff plant is readily accessible to major supply sources and is close to deep water transportation with terminal facilities providing economical product landing in principal consumption centers.

Bolted Structures Kept Tight Under Severe Service Conditions

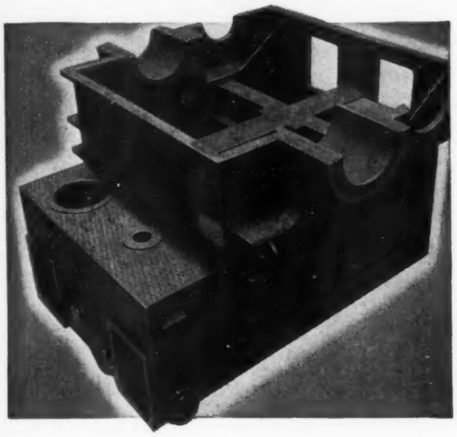
Spring Washers play an important part in the principal products of our company recenty stated J. R. Newkirk of the National Pneumatic Co. Their units of equipment are used in power operation and control of the doors of gas buses, electric trolley buses, street cars, subway and elevated railroad cars, elevator and dumb waiter equipment, wire drawing and wire insulating machinery.

All of this equipment is subject to a tremendous amount of wear and tear due to its constant use, and service conditions are,

Continued on Page 16

IF ROLLED STEEL CONSTRUCTION WILL IMPROVE YOUR PRODUCT-

. . . THESE *Special Steels* will improve it still more!



Standard Shapes Save Money Here. In this gear reduction case I-beams, plates, pipe, tubing, pipe fittings, and floor plate are effectively combined at low cost by welding, to produce a single structure.

LIGHT weight, improved appearance, lower cost, speedier production are the obvious advantages that the use of rolled steel offers the equipment builder.

But more important than these is the fact that in redesigning a product for rolled steel construction the engineer has at his disposal the entire range of modern metallurgy's special steels. Steels with special properties to overcome the destructive forces your product will meet in service. For example:—

To carry tremendous bearing pressures safely, there are several special analyses of U·S·S Carilloy Alloy Steels.

To reduce abrasive wear and cut down replacements, there is U·S·S Abrasion-Resisting Steel.

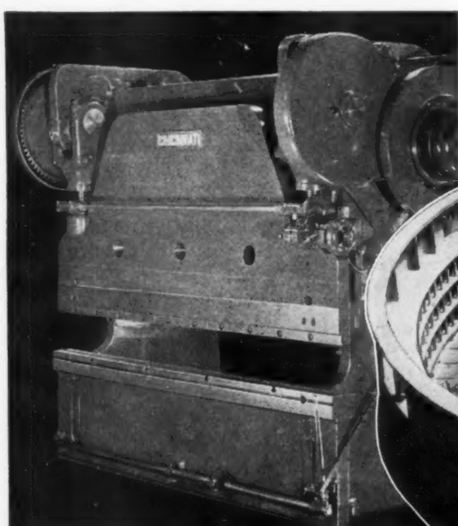
To endure high temperatures that spell disaster to other metals, there are U·S·S Heat-Resisting Steels.

To carry high unit stresses and reduce weight to a minimum, there are U·S·S High Tensile Steels.

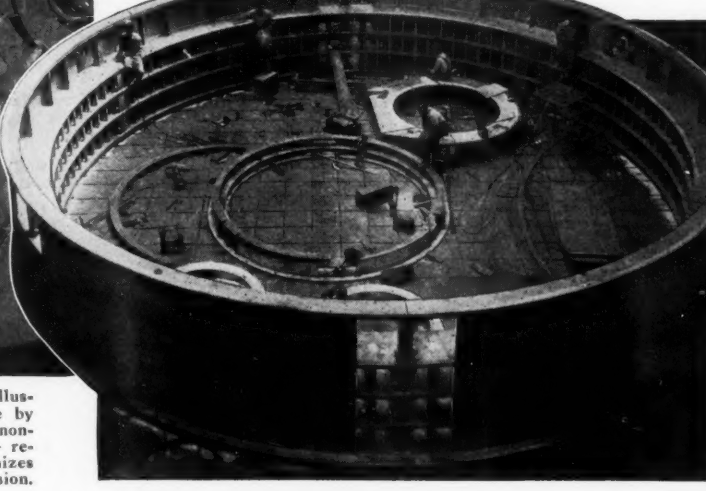
To resist corrosive environments, there are U·S·S Stainless Steels in special analyses which can be welded with no loss in corrosion-resistance.

Rolled steel construction permits you to pick these and other steels to exactly fit each job. Allows you to place these steels where they will do the most good. Makes it possible to combine one special steel with another. Or to combine them with castings wherever such combination seems desirable.

Our experience in selecting rolled steels of the right analysis to simplify your fabrication and to insure the ultimate in service is yours for the asking.



Compact—Modern. This brake press illustrates the smooth, simple lines obtainable by rolled steel construction. Elimination of all non-essentials secures strength without bulk — reduces weight—conserves floor space—minimizes shipping costs — increases operating precision.



Produced Direct From Drawings. Expensive patterns only infrequently used, are dispensed with in building this massive stator frame for vertical water wheel generator. Every unit shown here is of rolled steel construction, illustrating how extensively this modern fabrication method is used by electric manufacturers to reduce costs and expedite production.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

• Keep Informed . . . *Continued from page 14*

therefore, about as severe as any mechanical device receives in daily use. The door control equipment must be built to withstand constant vibration as well as the shocks caused by starting and stopping of transit vehicles. It must also withstand the jarring and straining imposed by rough roads. Furthermore, in vehicles, the mechanism must be in constant operation to take on and discharge passengers. It is vital to the smooth functioning of the controls that all working parts be constantly held in their original positions, and every precaution must be taken to allow for wear, stretching of bolts, and other causes of looseness.

Certain units of the door control equipment must be built so that they can readily be disassembled—either partially or wholly—for inspection, lubrication, and for easy replacement of worn parts. All such units are, therefore, bolted together.

Because helical spring washers provide long range of action, they have found them indispensable in compensating for looseness caused by wear of contacting parts, bolt stretch, temperature changes, etc. The spring action of the spring washer keeps a constant pressure on the nuts, thus preventing them from turning backward on their threads, and—at the same time—avoiding the danger of failure of the mechanism through loss of nuts from bolts. These might otherwise come off, due to the constant vibration.

In elevator or dumb waiter equipment, many parts must, of necessity, be assembled in the field. It is, therefore, in many cases more convenient to use bolts and nuts than rivets. Here, again, we have found that the use of spring washers is the best solution to the problem of failure due to looseness.

Wire drawing and wire insulating machines are further examples of equipment which must stand hard usage, as they operate at very high speeds, and more than the usual number of stresses and strains are set up. There are also a number of parts which must be changed from time to time in the operation of this equipment, such as gears that govern the size or type of out-put. To facilitate the changing of these gears, they are keyed to a shaft and held in position by a nut. As it is vital that these gears stay in place, we use a heavy spring washer under the nut, and we have never experienced any trouble with it working loose.

Through all these various experiences in our own plant, our draftsmen have become accustomed to specify helical spring washers under bolt heads or nuts, as we have found this to be the most efficient method of making sure that the products that leave our plant remain tight and trouble-free during their useful life. We felt that, considering the low cost of this device, it is very cheap insurance against trouble arising from wear, vibration, stretching of parts and other causes of looseness.

Long Life Chain Drive

Exceptionally long life is as newsworthy in the chain drive field as it is in the world of people. So this item from Morse Chain Company, Ithaca, N. Y., of one of their Silent Chains still rolling merrily along at the ripe old age of 18 years, will be interesting to power transmission and machinery men.

In 1912, the American Wringer Company, Inc., of Woonsocket, R. I., installed a 400 h.p. Morse Silent Chain with 3" pitch, 12" wide to transmit power from a steam engine to a line shaft. In 1920, a replacement chain was necessary because the concrete pit in which the drive operated was too shallow and the chain rubbed on the concrete with the unavoidable result.

But with the installation of the second Morse Silent Chain on the drive, the pit was deepened, and since 1920—18 long and busy years—the drive has operated on almost continuous 24-hour duty. During those 18 years, there has not been a single repair made on the Morse chain!

Recent inspection of the drive showed the original sprockets, which have 26 years of duty behind them, to be in excellent condition. The Morse Chain itself could stand repinning—all that would be necessary to put it back in tip-top shape.

So the end of this story of long, useful chain life has not yet been written; there are many more years of service in this 18-year old Morse Silent Chain drive!

• *BUSINESS CHANGES*

International Nickel Expands Technical Field Service

A. J. Wadhams, Vice-President and Manager of the Development and Research Division, of The International Nickel Company, Inc., 67 Wall Street, New York, N. Y., has announced the establishment of a new field office located in the Grant Building, Pittsburgh, Pa. The office, which was opened June 1st, is under the direction of H. V. Beasley, who for the past three years has been attached to the New York office.

The main function of this office will be to promote applications of Nickel alloy steels and products of the Huntington Mill and stimulate interest in Nickel cast irons and the use of Nickel in non-ferrous alloys. This is the fifth field office opened by the Development and Research Division to give manufacturers in the various industrial districts prompt service in handling their metallurgical problems. Other offices are located in Los Angeles, Calif., Chicago, Ill., Detroit, Mich., and Hartford, Conn.

Kingsbury Management

Effective June 1st, Nelson Ogden became General Manager of Kingsbury Machine Works, 4316–28 Tackawanna Street, Philadelphia, Pa., to succeed H. A. S. Howarth, resigned May 31st. The management of this bearing business is now in the hands of Mr. Ogden, Arthur B. Lakey as Chief Engineer, and A. K. Dennis as Comptroller and Secretary.

These appointments were recently announced by Albert Kingsbury, President.

Allis-Chalmers Boston Office

Allis-Chalmers Mfg. Company's Boston Office has been moved to the Park Square Building located at 31 St. James Avenue. W. F. Taylor remains in charge as manager.

L. F. Adams Named Manager of New G-E Standards Department

According to a recent announcement, Lee F. Adams, formerly associated with General Electric's Commercial General Department, has been named manager of the Company's newly formed Standards Department. Mr. Adams will also act as assistant to Vice President E. O. Shreve. In his new capacity, he will have the responsibility of co-ordinating all activities pertaining to the development and application of standards throughout the Company's organization. His department

Continued on Page 18

 Continued from page 16

will also work with various local, national, and international associations and agencies interested in standards.

Mr. Adams, who is a native of Bellefonte, Pa., graduated from Pennsylvania State College with the bachelor of science degree. He became associated with General Electric in 1906 when he entered the test course at Schenectady. After a year, he returned to his alma mater as an instructor and in 1909 he was awarded a degree in electrical engineering. The following fall, he returned to General Electric as a member of the Induction Motor Engineering Department. In 1912, he was transferred to the Industrial Engineering Department and it was while associated with this organization that he became active in matters concerning Company standards and codes.

In 1929, he was transferred to the Commercial General Department. Here, his assignments included the following of outside contacts of the Company having to do with codes, standards, and related activities with various national and international associations. He has been a member of the American Institute of Electrical Engineers, of the U. S. national committee of the International Electrotechnical Committee, and other trade groups. As Company representative in the National Electrical Manufacturers Association, Mr. Adams has been chairman of the codes and standards committee and he represented the N.E.M.A. on the standards council of the American Standards Association.

In 1930 he was the recipient of the James H. McGraw award to electrical manufacturers "in recognition of his constructive contribution to the manufacturing branch of the electrical industry through his long and arduous service and his outstanding leadership in the co-ordination and advancement of the standardization and simplification of electrical products."

Pangborn New England Offices

Pangborn Corporation announces the removal of their New England Offices to 175 State Street, Springfield, Mass., to be in charge of J. H. Connolly, who was previously connected with the Company's Detroit Office. Mr. Connolly's experience as District Sales Engineer in Detroit and previous experience in the capacity of Erecting Superintendent and Service Engineer for the Pangborn Corporation fully qualifies him to serve Pangborn's many friends and customers in the New England area.

• LATEST CATALOGS

Self-Sealed Bearings

Norma-Hoffmann Bearings Corporation, Stamford, Conn., has just issued a circular which briefly outlines some results of a long and extensive study in their Research Engineering Department with a view to safeguarding further the high quality of their bearings in the interval between manufacture and actual application.

Reeves Variable Speed Control Equipment

Reeves Pulley Co., Columbus, Ind., has just issued a new 124-page catalog (No. G-384) covering the complete line of REEVES variable speed control equipment in one compact, easy-to-use volume. This is the first time that all three REEVES speed control units—Variable Speed Transmission, VariSpeed Motor Pulley and Motodrive—have been cataloged together in one book. The entire book is printed in two colors and each of the three sections is printed in a different color combination for ready identification. Mechanical binding of the $8^1/_2 \times 11$ pages permits the book to lie open perfectly flat.

The book is bound in a heavy-weight black cover handsomely embossed in gold. More than 200 illustrations are used. Twelve pages are devoted to illustration of installations and uses in many different industries. Twenty-three pages are devoted to engineering data on the REEVES Transmission; 11 pages to engineering data on the VariSpeed Motor Pulley; and 19 pages to the Motodrive. All dimension drawings are notably large and easy to read.

Molybdenum in Steel

Announcement has been made of a newly published book on molybdenum steels issued by the Climax Molybdenum Company, 500 Fifth Ave., New York, N. Y.

It is a reference book of technical data covering the characteristics, uses and applications of the various forms of molybdenum steels. For convenience it contains a general index and is in loose leaf form. It represents a compilation of the most useful data on all types of molybdenum steels, both wrought and cast.

Every effort has been made to present the data in the most convenient form for practical use. The book is divided into several sections, including an introduction. Each steel is covered in a separate section, in addition to which there are sections on steel for elevated temperature service, corrosion resisting steels, and cast steels.

Rockford Over-Center Clutches

The Rockford Drilling Machine Division of Borg-Warner Corporation; 114 Catherine Street, Rockford, Illinois, manufactures three types of clutches—Pullmore Multiple Disc Clutches; Rockford Spring-Loaded and Over-Center Clutches. Made in a wide range of sizes, proved by a large number of highly successful installations, there have been minor improvements in design and manufacture, and many new applications for all of these clutches during recent years, but no newsworthy major changes until the release of the new Roller Cam feature of Rockford Over-Center Clutches.

A new circular is now available containing illustrations, diagrams, and a brief description of the more important features and advantages of Rockford Over-Center Clutches including the Roller Cam feature.

Spring Machinery Bulletin

The Torrington Manufacturing Company of Torrington, Connecticut, has just released an attractive and colorful illustrated bulletin describing the advantages and features of its segment and clutch type spring making machines. Specifications for each type of spring making machine are shown in table form on the back page of the bulletin.

Flame Hardening

An illustrated booklet, "Flame Hardening," has just been published, describing the process whereby the surface of an iron or steel product is locally heated by means of an oxy-acetylene flame and then hardened by rapidly quenching in water, leaving the core of the metal tough and ductile. The process as described is highly flexible, and is readily adaptable to a wide variety of sizes and shapes of parts. The booklet discusses the advantages of the process, and describes the necessary equipment and the various flame hardening methods employed—stationary, progressive, spinning and combination. A table is included listing a number of steels particularly suited for flame hardening. Copies can be obtained from The Linde Air Products Company, 205 East 42nd Street, New York, N. Y.

Brown Air-Operated Controllers

The Brown Instrument Co., 4496 Wayne Ave., Philadelphia, Pa., has just published a new folder on Air-Operated Controllers. The adaptability of Brown Air-Operated Controllers to the varied control requirements of industrial processing is demonstrated in a representative list of fifty applications. Several interesting installations are illustrated.

Poole Flexible Couplings

Poole Foundry & Machine Co., Woodberry, Baltimore, Md., has just announced an outstanding piece of trade literature devoted exclusively to flexible shaft couplings. It tells of their value and many advantages and embodies data, tables and information that has not yet been presented in catalogs of this nature.

"Universal Unaflow" Engines

Skinner Engine Company, Erie, Pa., have just issued a new catalog describing their horizontal "Universal Unaflow" Steam Engines. The unaflow principle is fully described, as well as the design and construction of the engines. Some typical installations are shown.

COMING MEETINGS AND EXPOSITIONS

For the next three months

AUGUST

9–12	American Institute of Electrical Engineers, Annual Pacific Coast Convention, Portland, Oregon.
29–Sept. 7	National Aeronautic Association, 3rd Annual Midwest Soaring Contest, Frankfort, Mich.

SEPTEMBER

3–5	National Aeronautical Association, 16th National Air Races, Cleveland, Ohio.
5–9	American Chemical Society, Fall Meeting, Milwaukee, Wis.
27–30	Association of Iron & Steel Engineers, Annual Convention and Iron and Steel Exposition, Cleveland, Ohio.

OCTOBER

5–7	The American Society of Mechanical Engineers, Fall Meeting, Providence, R. I.
10–12	American Gear Manufacturers Association, 21st Semi-Annual Meeting, Skytop, Pa.
10–14	National Safety Council, Silver Jubilee Congress, Stevens Hotel, Chicago, Ill.
Wk. of 10th	American Gas Association, Annual Convention, Atlantic City, N. J.
12–14	American Society of Civil Engineers, Fall Meeting, Rochester, N. Y.
14–16	Second International Aerobatic Competition and St. Louis Air Races, St. Louis, Mo.
16–21	American Welding Society, Annual Meeting, Detroit, Mich.
Wk. of 17th	American Society for Metals, Annual National Metal Congress, Detroit, Mich.

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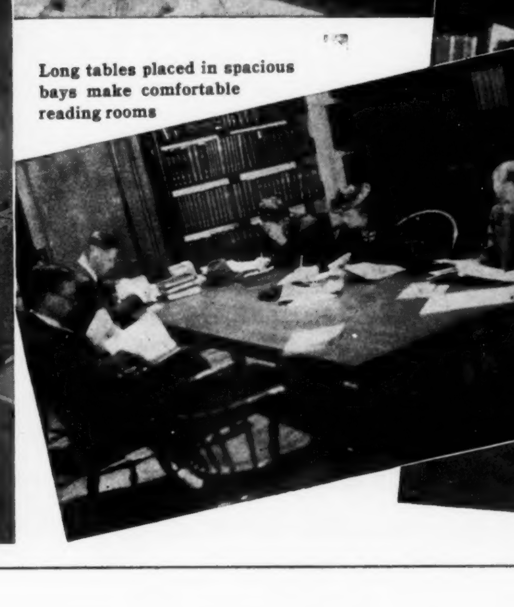

"If I were an ADVERTISING MANAGER":

That's just one of the talks to be delivered anonymously by a masked speaker that will set every man thinking at the Annual Conference of National Industrial Advertisers Association in Cleveland, September 21-23. A second masked speaker will tell what he would do if he were a publication representative.

We're not going to tell you much here—just highlight the program enough to make your mouth water and your brain tingle.

T. M. Girdler, Chairman, Republic Steel Corporation, is scheduled for the opening address and when "T. M." talks he says something.

J. H. McGraw, Jr. will talk on "What I Would Do *Now* If I Were An Industrial Advertising Manager."

The new Publisher's Statement will receive full discussion.

Clinic sessions, so popular last year, will again cover a wide range of interesting subjects. Two half-day sessions instead of one.

A general conference session will cover such subjects as "Preparing the Plan", "How to Gather Usable Material", "Copy Technique", "How to Sell Management", "Co-ordinating Sales and Advertising" and "How and Why to Use an Industrial Agency."

Another session will deal with "Problems of the Small Advertiser", "Production Problems", "Public Relations"—and there are many others.

If I were an Advertising Manager, I certainly would start now to make plans to attend the 16th N. I. A. A. Conference even if I had to hitch-hike to Cleveland. And I would send in my advance registration now to—Ed. Bossart, Bailey Meter Company, Ivanhoe Road, Cleveland, Ohio.

IF I EMPLOYED AN ADVERTISING MANAGER—I would make certain that he attended this Conference, because changing times and markets demand a changed viewpoint—a new viewpoint that can be obtained only by hearing discussions by men whose experience is up-to-the-minute—right up to September 21st.

NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION

100 EAST OHIO STREET • CHICAGO, ILLINOIS